AUGUST 1958

Power Engineering

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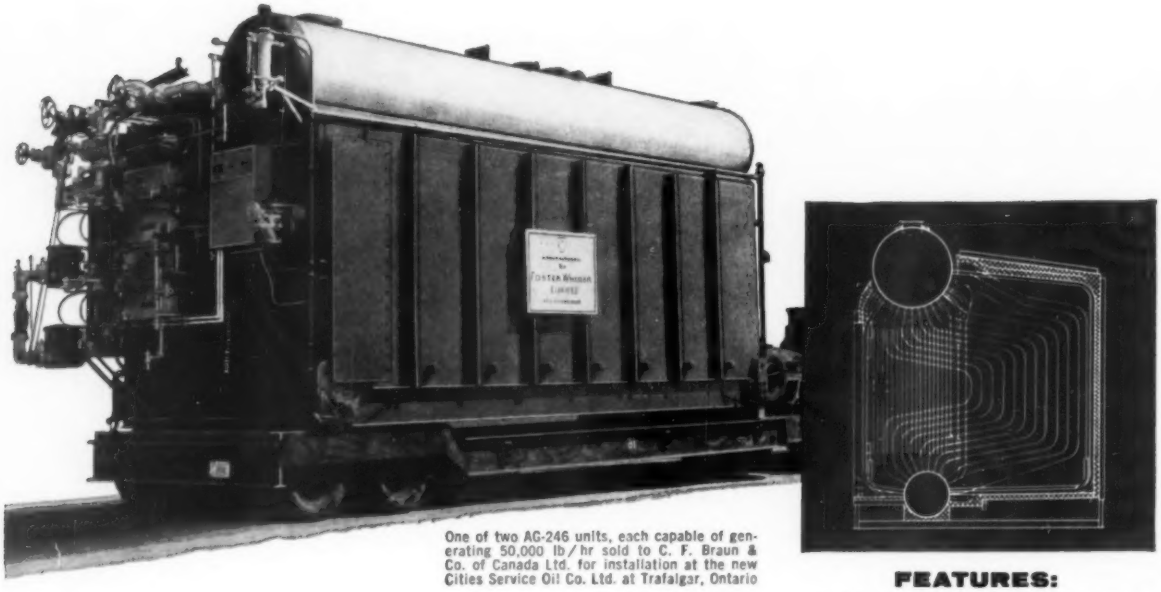
HIGH CAPACITY PACKAGED STEAM GENERATORS

by Foster Wheeler



One of two AG-246 units, each capable of generating 50,000 lb/hr sold to C. F. Braun & Co. of Canada Ltd. for installation at the new Cities Service Oil Co. Ltd. at Trafalgar, Ontario

Series AG-200 extends economy and dependability of FW Packaged Design to over 60,000 lb/hr

To meet the needs of industrial plants for high-capacity Packaged Steam Generators, Foster Wheeler offers units for capacities of 50,000 to 63,000 lb/hr and higher, depending on operating conditions.

A modification of the proven AG-100 design which has provided industry with reliable, economical steam in the range of 10,000 to 50,000 lb/hr, these compact, space-saving units permit more steam capacity in less space than has heretofore been possible. For complete details, write to *Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N. Y.*

FEATURES:

- Final Steam Temperatures to 840 F
- Design Pressures to 900 psig
- Standard Heat Recovery Arrangements Available
- 42-inch Steam Drum
- Two Burners
- Automatic Controls
- Suitable For Indoor or Outdoor Installation
- Tangent Bare Tube Furnace Side Walls and Roof
- Staggered Boiler Bank Tube Arrangement
- Fully Drainable and Removable Superheater.

THE FOLLOWING AG-200 UNITS ARE NOW IN PRODUCTION:

Capacity lb/hr	Operating Pressure psig	Final Steam Temperature Deg. F	Feedwater Temperature Deg. F	Fuel	Efficiency	Steam Quality
52,500	400	750	200	No. 6 Oil	85.5	3 ppm Solids Carryover
60,000	285	Sat.	220	Nat. Gas	78.3	3 ppm Solids Carryover
63,700	150	Sat.	225	No. 6 Oil	83.7	0.5% Moisture Carryover
68,000	620	Sat.	350	No. 6 Oil	80.9	1 ppm Solids Carryover

FOSTER WHEELER

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

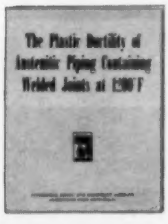
For more data circle 501 on Post Card

ALL IN A DAY'S WORK at *Pittsburgh Piping*

STAINLESS STEEL AUTOCLAVE and VOLUTE
Shop Fabricated

by *Pittsburgh Piping*

This autoclave and volute assembly is typical of the work that goes through Pittsburgh Piping shops. Fabricated of Type 304 Stainless Steel, it is complex in design and is built for high pressure, high temperature service. This type of fabricating is a "natural" for Pittsburgh Piping. We pioneered the application of austenitic steel piping materials for central stations operating at 1050°F. and above, and fabricated the piping for the world's first atomic-powered submarine and central station. Highly specialized methods, machines, and apparatus have been developed and are employed in this work. Use them on your high temperature, high pressure piping jobs.



WRITE FOR YOUR COPY

This bulletin reports an intensive investigation into the problem of main steam piping materials and gives data on the stress rupture characteristics of Types 316 and 347 stainless steel piping adjacent to welded joints.

Promoting Progress ***IN POWER AND PROCESS PIPING***

Pittsburgh Piping **AND EQUIPMENT COMPANY**
158 49th Street—Pittsburgh, Pa.

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For more data circle 502 on Post Card

What made Thief River Falls decide on STANDARD D&G Oil

Two Fairbanks-Morse OP engines turn in top-rated performances with this lubricant.

The situation: In January of 1952 the Thief River Falls, Minnesota, municipal light plant put into service a 10-cylinder, 1,600 hp. Fairbanks-Morse opposed piston engine. In November, 1955, a 1,900 hp. Fairbanks-Morse OP engine was added.

What was done: The power plant management discussed lubrication requirements with Standard Oil lubrication specialists. Because of the evidence that STANDARD D&G Oil, with its higher additive level, could (1) reduce ring and wall wear, (2) reduce ring sticking, (3) increase bearing life and (4) reduce engine deposits, this oil was selected for the first engine installed. After 22,000 hours, inspection showed little or no wear. Small wonder then that when the second OP engine was put into service in 1955, STANDARD D&G Oil was again selected. After 7,500 hours, similar performance is being obtained on the newer engine.

Technical service performed by Standard Oil men pays off for the power plant management. Standard men take frequent samples for field inspection of oil condition. Other samples are regularly taken for transmittal to Standard's Whiting, Indiana, laboratory for complete analysis.

What you can do: Get more facts about STANDARD D&G Oil from the Standard Oil lubrication specialist near you in any of the 15 Midwest and Rocky Mountain states. Or write **Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.**

Taking a look at the record. Morris L. Owen, plant superintendent (left), and Standard Oil's Carl Klenner look at performance data on the two Fairbanks-Morse OP engines. Carl is a good one to talk things over with. He has been doing this sort of work for 10 years with Standard. Before that he received an engineering degree at the Michigan College of Mining and Technology and completed the Standard Oil Sales Engineering School.

Quick facts about STANDARD D&G Oil

- Made from highest-quality solvent-refined stock.
- Contains additives which impart superior detergent-dispersant and anticorrosion properties.
- Antifoaming.
- Oxidation-resistant.
- Recommended for use (1) with economy fuels (2) in extreme-load and/or low-temperature service.

You expect more from STANDARD *and get it!*

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PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL PLANTS

ENGINEERS' PREVIEW

PEAK LOAD pattern for electrical demand for 1958 through 1960 emerges from Edison Electric Institute's 23rd semi-annual electric power survey. December, 1958 peak is expected to be about 120,000,000 kw, only 2.5 per cent below the prediction made last fall, and nearly 12 per cent greater than last winter's peak. Gross margin of generating capability over demand is estimated to be about 23 per cent for next December.

The 1959 December peak is predicted at 129,000,000 kw, with capability of 159,000,000 kw. Same month in 1960 is forecast at about 138,000,000 kw, and capability of more than 170,000,000 kw.

Summer peak load for this year is forecast at 115,700,000 kw. It should be 145,600,000 kw by 1961, the survey predicts.

These forecasts show only small revisions downward from previous predictions.

The survey also reveals that construction of new facilities by electric power systems in the U. S. is proceeding at a record rate, with about 15,750,000 kw of new capacity scheduled for service this year.

JOHN I. YELLOTT announces the formation of John Yellott Associates with headquarters at 901 West El Caminito, Phoenix, Arizona, to render consulting services in the field of mechanical engineering. He is a registered professional engineer in Arizona, Maryland, and New Jersey.

From 1940 to 1945, Yellott was head of the Department of Mechanical Engineering and Director of the Institute of Gas Technology at Illinois Institute of Technology in Chicago. From 1945 to 1955, he was director of research for the coal-burning gas turbine program of the Locomotive Development Committee, Bituminous Coal Research, Inc. During 1956 and 1957, he was an assistant director of Stanford Research Institute and executive director of the Association for Applied Solar Energy, in Phoenix, Arizona.

MEETINGS AHEAD: 5th ASME-ASLE Lubrication Conference, Los Angeles, Statler Hotel, October 13, 14 and 15.

Mid-America Minerals Conference of American Institute of Mining, Metallurgical and Petroleum Engineers, St. Louis, Mo., Chase-Park Plaza Hotels, October 23–25.

Fifth Electrical Conference of the Petroleum Industry, sponsored by AIEE, Dallas, Texas, Baker Hotel, September 15–17.

ASTE semi-annual meeting and Western Tool Show, Los Angeles, Shrine Exposition Hall, September 29 through October 3.

JEFF HUNNICUTT, long known to POWER ENGINEERING readers as an author, comes to the editorial staff direct from his last job as start-up engineer at Delaware Power & Light's new Indian River Generating Station.

Born in Texas, he spent two years at Baylor University before entering the U. S. Maritime Academy in March, 1941. He served in the U. S. Merchant Marine throughout the war, and holds a chief engineer's ticket. He was graduated from Texas A & M in 1948 with a Bachelor's degree in Mechanical Engineering, and did graduate work at Rice Institute.

After graduation, Jeff was successively power supervisor, power superintendent, superintendent of utilities, plant start-up and betterment engineer, design engineer,

consulting steam engineer, construction superintendent, and project manager, with such concerns as: Westvaco Chemical Division of Food Machinery & Chemical Corp, Great Northern Paper Co, Ebasco International, Stone & Webster Engineering Corp, The Kuljian Corp, and United Engineers & Constructors.

A registered professional engineer in several states, his activities in power plant construction, start-up, operation and betterment, have taken him from Sao Paõlo to Sault Ste. Marie and from Caracas to California.

NEW CORROSION INHIBITORS to supplement or replace petroleum sulfonates as lubricant additives, have been the objective of a year of Air Force-sponsored research. Final report on this work has been released for industry use through the Office of Technical Services, U. S. Department of Commerce. It's called PB 131459, Corrosion Preventive Additives, has 120 pages, may be ordered at $3 a copy, from OTS, U. S. Department of Commerce, Washington 25, D. C.

A large number of commercially available organic compounds were evaluated by the static water drop test and a galvanic couple system. Several good inhibitors were found, and general information was obtained concerning the type of organic compounds which will inhibit galvanic corrosion.

The research produced many synthetic organic compounds showing corrosion-inhibiting properties.

THREE REASONS for a bright future for gas turbines in utility systems are cited by Guy Suits, GE's director of research:

First, there are no longer enough old, inefficient stations around to meet peak requirements.

Second, Suits points out that the substantial and rapid improvements in efficiency, which in the past have made it uneconomical to delay installing new base-load machines, are almost certain to be less rapid in the future. A system saturated with generators nearly as efficient as the best available can look toward accepting slightly less efficient peak-load units.

Third, Suits advances the point that gas turbines are now being built in sufficient size so that they have a definitely lower first cost when compared to other types of peak-load installations. Efficiencies are increasing also, some of the larger units having a thermal efficiency of 25 to 27 per cent.

NEW HEAD of Illinois Institute of Technology's department of mechanical engineering is Andrew A. Fejer, who succeeds retiring director Frank D. Carvin. Fejer comes to IIT from the University of Toledo, where he was professor of aeronautical engineering for nine years. He also taught at Cal Tech and the University of Michigan, and has done consulting work for the General Electric Co, S. Morgan Smith Co and A. O. Smith Corp. A graduate of the Technical University of Prague, he received his master's and Ph.D. degrees in aeronautical engineeering from California Institute of Technology.

UP-TO-DATE in-plant or home study course on nuclear metals is now being offered by Metals Engineering Institute, a division of the American Society for Metals, Cleveland 3, Ohio. It's called Metals for Nuclear Power, has 15 lessons, was written by David W. Lillie, former MIT group leader and AEC staff member. It is recommended for those with a B.Sc. degree in metallurgy, or the equivalent in practical experience.

Illinois Institute of Technology in Chicago announces a new undergraduate curriculum in engineering sciences. Program will stress mathematics and science and basic courses in several phases of engineering. New curriculum has been designed to satisfy growing demands from industry and government for men trained to develop and apply fundamental engineering knowledge.

AMERICAN BRANCH of the Society of German Engineers (VDI) has been established, under the presidency of H. B. Kulose. Address is 4850 Balfour Rd, Detroit 24, Mich. Verein Deutscher Ingenieure was founded in 1856, has more than 34,000 members in the western zone.

MILESTONE in the electric power industry has been reached in the completion of a 90-mile extra-high-voltage power line between Orland Park, Ill., and New Carlisle, Ind. The $28,000,000 line links the Commonwealth Edison and American Electric Power Co (for) merly American Gas & Electric-systems. The 345,000-v line is the nation's largest for interchange of a bulk electricity supply between two power systems.

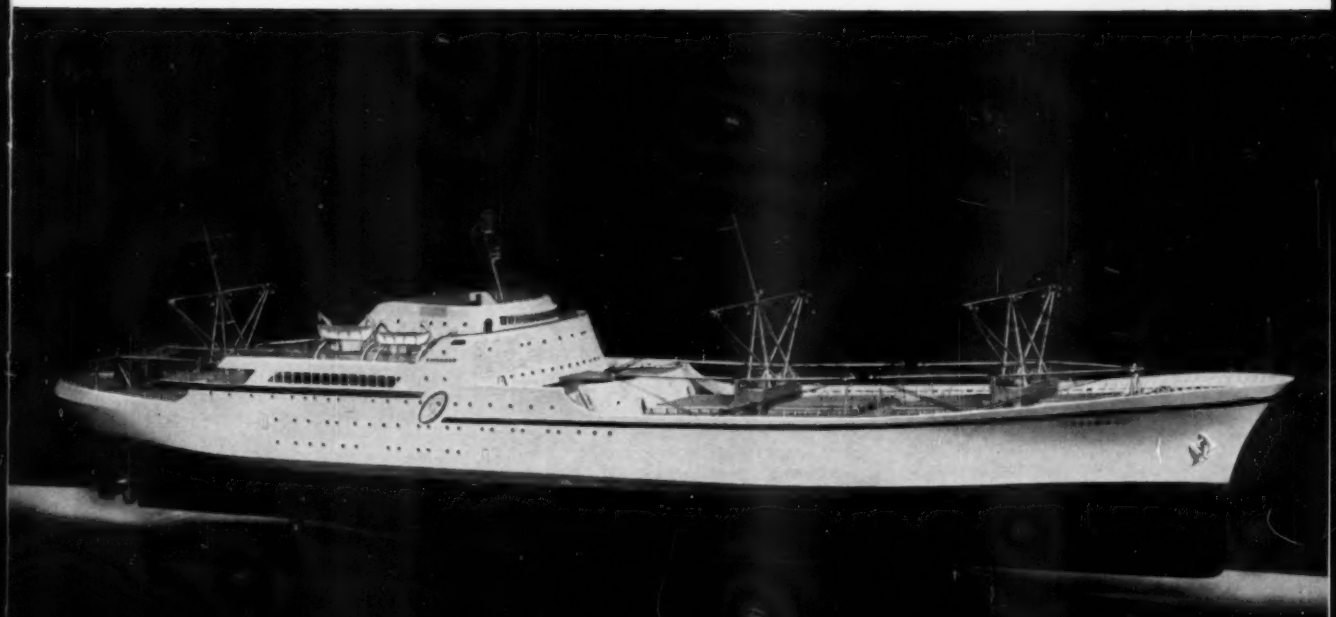
AIEE'S new president is L. F. Hickernell of Dobbs Ferry, N. Y. He was elected 1958–59 head of the Institute at its summer general meeting in Buffalo. Hickernell is vice president for engineering for Anaconda Wire and Cable Co. He began his AIEE presidency August 1st.

AIEE has elevated seven of its members to the grade of Fellow. They are: William B. Loper, chief engineer, California Electric Power Co; Edward R. Moore, manager of engineering, Detroit Edison Co; Richard F. Stevens, chief of design, Bonneville Power Administration; Frederick T. Bear, vice president in charge of engineering, Delaware Power & Light Co; Milton Eaton, consulting electrical engineer, Quebec; Francis X. Lamb, vice president, engineering, Weston Instruments; Robert O. Loomis, chief planning engineer, Georgia Power Co.

NEWLY organized is the Society for the History of Technology, a group of scholars concerned to assess the impact of technology on society. The group will sponsor meetings and plans to publish a quarterly, *Technology and Culture*. Chairman of the executive committee is Melvin Kranzberg of Case Institute of Technology.

NUCLEAR NEWS from Stone & Webster Corp is its acquisition of the research and development facilities of Associated Nucleonics, Inc, of Garden City, N. Y. This is the company formerly known as Walter Kidde Nuclear Laboratories, Inc. Wilbur E. Kelley remains as president of Associated Nucleonics. S & W's president, T. Cortlandt Williams, becomes chairman of the board of the new subsidiary.

Creative Engineering by DE LAVAL



One of the U.S. Government's exhibits at the Brussels World's Fair is the model of the first nuclear ship, the N/S SAVANNAH, shown above.

The De Laval Steam Turbine Company is proud to play an important part in the design and construction of this 22,000 shaft horsepower vessel, the keel of which was laid on May 22, 1958, Maritime Day, at the New York Shipbuilding Corp. in Camden, New Jersey.

Under the joint sponsorship of the Atomic Energy Commission and the U. S. Maritime Administration, major contributions to the design and construction of the vessel and its machinery are being made by:

- *George G. Sharp, Inc., naval architects, designers of the vessel*
- *Babcock & Wilcox Company, designers and builders of the pressurized water reactor and its accessories*
- *New York Shipbuilding Corp., Camden, N. J., builders of the vessel*
- *De Laval Steam Turbine Company, designers and builders of the main propulsion machinery, other engine room auxiliaries; coordinators of all engine room equipment.*

We are particularly happy to serve in connection with this project of international importance. De Laval has often performed other important services as complete engineering coordinators, and is fully prepared to undertake similar assignments.

DE LAVAL *Steam Turbine Company*

816 Nottingham Way, Trenton 2, New Jersey

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WHAT THEY TELL US

▶ **WHAT MAKES A GOOD COVER** — for a power engineering magazine? This is a debate which goes on indefinitely, but our present answer — the cover which is basically a contents page — continues to get confirmation from our readers. Latest note on this comes from John S. Polancik of William Beaumont Hospital in Royal Oak, Michigan, who writes:

> I like the way you index the contents on the cover, as it makes finding an article much easier when going back through the magazines. I would like to see you use a tear-out index that could be put in with the Handbook section of the magazine. This would make it easier to locate articles in back issues.
>
> I look forward to each issue of your publication, and devote my lunch hour to reading it from cover to cover. I enjoy the great variety of articles, especially those pertaining to steam generation, turbines, pumps, air conditioning and refrigeration, and the general maintenance of buildings and equipment.

▶ **FAN MAIL** accumulates for our ATOMICS section, which since December of last year has been appearing every other month under Andy Kramer's editorship covering current and forthcoming developments in nuclear power throughout the world. Writes James F. Mumper, manager of James F. Mumper Co of Akron, Ohio:

> We find the articles published in your magazine very interesting and unusually well done. We are very much interested in the articles you have published on atomic power and reactor design. These articles are the best we have seen on this development.

▶ **PUMPED STORAGE** for circulating water is a subject close to the heart of reader F. W. W., who sends out this S.O.S.:

> We have been discussing for a long time the idea of pumped storage for circulating water, and I have not been able to convince some of my colleagues that it is a practicable scheme.
>
> It seems to me that there would be many locations where circulating water pumps could be used during periods of low load to pump water *through* the condenser, and into a natural or man-made reservoir. Then, at peak load periods, the same water could be dropped through the condenser (and such other heat exchanging equipment as might be desirable), without the use of pumps.
>
> In many stations this would reduce the station power load materially, and increase the net generation by two or three per cent.
>
> Do you know of any installations where this or a similar system has been used? Since quantities are much smaller than those used where pumped storage is for subsequent generation, there should be many places where it might be practical. With a constantly available head for cooling water, it would probably be possible to eliminate several of the smaller pumps, motors and switchgear usually required for this purpose.
>
> Certainly would like to have some concrete evidence to help me win my point!

▶ **DEAN** of electrical engineers still active in their profession in the Chicago area undoubtedly is Leo Dolkart, who at 77 is still pursuing the many-sided career which for 50 years has marked him as an outstanding engineer and person.

Born in Russia, as a boy Dolkart emigrated to this country with his family. He graduated in electrical engineering from the University of Illinois in 1903, and got his start in Moline, Ill., where he was soon active in civic affairs as well as engineering.

Leo Dolkart of Chicago

Later he centered his activities in Chicago, where he is still carrying on not only as a consulting electrical engineer but as editor of *Sci-En-Tech News*, as treasurer and secretary of Future Engineers of America, as chairman of the finance committee and treasurer of the 1958 Appliance Technical Conference, as an active committee member for AIEE and the Illuminating Engineering Society — to list only a few of his present interests. Dolkart says:

> I do not consider myself extraordinary but I am conscious of my responsibilities to my profession, my country and my community. It is for this reason that I take on jobs that I am physically able to do.
>
> I came to this country when I was 12 years old and had to work hard. I sold newspapers, worked in machine shops and glove factories. At the university, although I had a four-year scholarship, I had a hard time financially. Among the various jobs I had to take to keep my meager food intake going was that of part-time janitor at the university, where I swept floors, mopped toilets, swept streets, cleaned brick, etc. I worked in a barber shop, took care of furnaces, worked in a mattress factory. So I believe that hard work does not kill, but perhaps whets the appetite.
>
> Sir Francis Bacon rightly said (to which I subscribe): 'I hold everyman a debtor to his profession; from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves by way of amends to be a help and ornament thereunto.'
>
> I cannot claim to be an 'ornament' but I feel that the least I can do is to help with the 'dirty work' that all groups have to do — civic, professionally and in the community. Somebody has to do it.

▶ **SIX POPULAR** articles on power plant start-up problems, authored by J. H. Hunnicutt for POWER ENGINEERING and now available in reprint form, continue to be helpful to a wide group of engineers. Writing for copies of the reprinted articles, Harold F. Louer of Sanderson & Porter Engineers in New York City, comments:

> Your magazine continues to rate highest for containing the type of information and advertising directly related to power engineering, and I take this opportunity to express my thanks to you for sending it here.

▶ **SPEAKING OF REPRINTS,** the article in the October, 1957 issue describing in detail how planning and ingenuity cut power costs at the St. Joe Paper Mill Co in Florida, has been very handsomely reprinted by Cummins & Barnard, Inc, Engineers. A. A. Cummins tells us that they will be glad to furnish copies of this reprint without charge to anyone who requests them. Write The Editor, POWER ENGINEERING.

Why Every Steam Heated Unit Needs its Own Steam Trap

. . . the theory, practice and proof of "unit trapping" for top temperatures

Using an individual trap for each steam heated unit, including each separate coil, chest or chamber of a machine—pays off for the user.

Here are just two examples:

1. On a creamery dryer

Drainage Method	*Air Temperature*
Restricted Blow-thru	250°
Group trapping (1 trap for 8 coils)	225°
Armstrong Unit Trapping (8 traps—1 for each coil)	**309°**

2. On a platen press

Drainage Method	*Processing Time*
Restricted Blow-thru	50 minutes
Group Trapping	35 minutes
Armstrong Unit Trapping	**25 minutes**

Why Unit Trapping Works Best

It is reasonable to assume that no two steam heated units will have *identical* condensing rates. Even the slightest difference in rate will cause a difference in steam pressure drops through the units. Here's where the trouble starts. Condensate from each unit may flow to the trap. But, what about air and other non-condensibles in the system? A difference in pressure drops too small to be indicated by an ordinary pressure gauge will permit backflow of steam from the higher pressure units to the lower pressure units. This backflow of steam may even impede flow of condensate from the lower pressure unit to the trap . . . and it will definitely impede or block off flow of air to the trap. The result is sluggish heating, reduced temperatures, reduced output, fuel waste and increased possibility of corrosion. Figures 1, 2 and 3 diagram the action.

Unit Trapping Not Costly

No engineer wants any more mechanical devices in his plant than are absolutely necessary. But, the moderate additional cost of using two or more small traps, instead of one big one, is saved over and over again in improved efficiency.

If the traps are Armstrong, maintenance is no problem. And users frequently tell us that Armstrong traps outlast others two and three to one.

Steam traps usually represent a fraction of 1% of the cost of the equipment they drain. Does it make good sense to lose 10% or more of equipment capacity to save a few dollars on traps?

Why not test Armstrong unit trapping in your plant. If you are not completely satisfied with the results you can return the traps for a full refund of the purchase price. There is little to lose—lots to gain. Call your local Armstrong Factory Representative or Distributor, or write **Armstrong Machine Works, 8102 Maple St., Three Rivers, Mich.**

ASK FOR the 44-page Steam Trap Book and reprint of article on Unit Trapping.

8015T

How Different Condensing Rates Can Slow Production

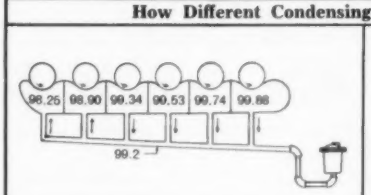


Fig. 1 This is a 6-roll ironer shortly after it has begun operating on 100 psi steam. When cold, wet material passes over chest 1, steam condensing rate is high and pressure drops accordingly. The pressure drop in chest 2 will not be as great, and so on down the machine as the material becomes progressively hotter and drier. Average pressure in the chests then is 99.27 lbs., and drain header pressure is slightly less, about 99.2 lbs. Under these conditions, steam from drain header enters chests 1 and 2 (as indicated by arrows at side of drain lines) because of pressure difference. Though condensate from chests drains by gravity, air can't leave chests countercurrent to incoming steam. Fig. 2 shows what happens next.

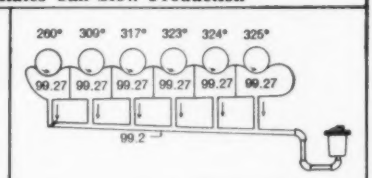


Fig. 2 This is the same 6-roll ironer after it has been operating a while. Air has accumulated in chests 1 and 2, reducing condensing rate and decreasing pressure drop. This process repeats itself down the line until pressures are as shown—that is, enough air will accumulate in each chest so that condensing rates and pressure drops of all chests will be about equal. The net result is shown in chest temperatures which are actual pyrometer readings taken on a 6-roll ironer, drained by a master trap, in a Chicago laundry. The laundry was making 337.9°F steam, but getting an average of only 309.6°F from the ironing surfaces, necessitating slow operation and frequent reruns. Then they tried Armstrong unit trapping—see Fig 3.

How Unit Trapping Prevents Trouble

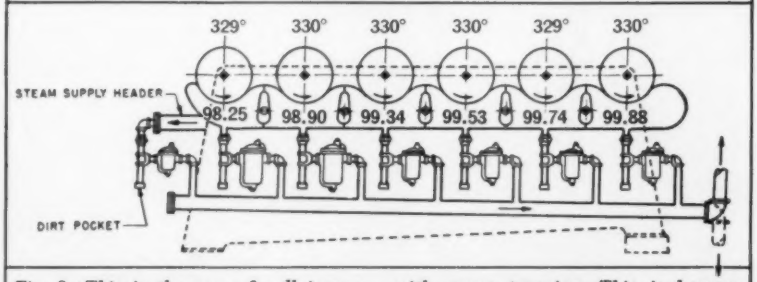


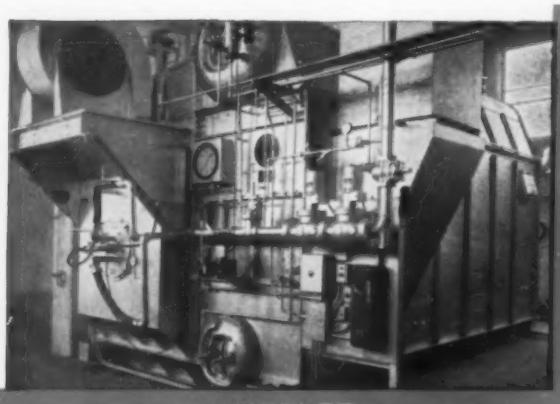
Fig. 3 This is the same 6-roll ironer, now unit trapped. Temperatures shown are also actual pyrometer readings—the average of 329.6°F is 20° higher than with group trapping. This is because air is continually removed from each chest into the drain header, and cannot get back into any chest.

ARMSTRONG STEAM TRAPS

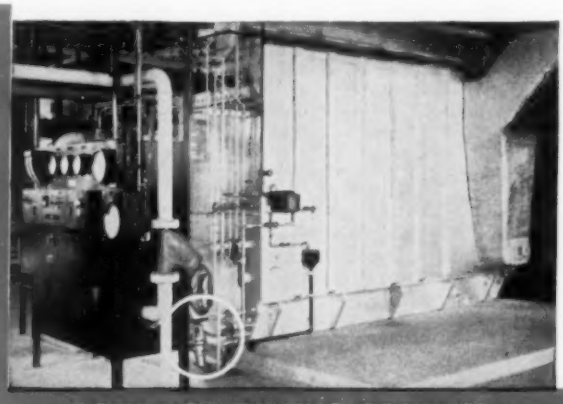
For more data circle 505 on Post Card

the blow-off valve trend on "package" boilers is

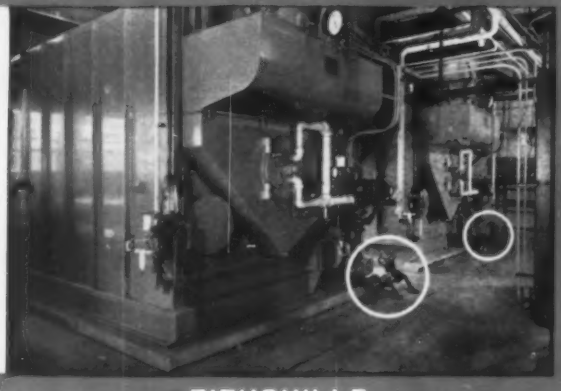
YARWAY SEATLESS



● E. KEELER



● COMBUSTION ENGINEERING



● TITUSVILLE

● KEWANEE-SPRINGFIELD

YARWAY® **BLOW-OFF**

■ More and more leading manufacturers of package-type boilers are featuring Yarway Blow-Off Valves on their units. Many are standardizing on Yarways.

The reason—good blow-off valves help good package boilers *perform better*.

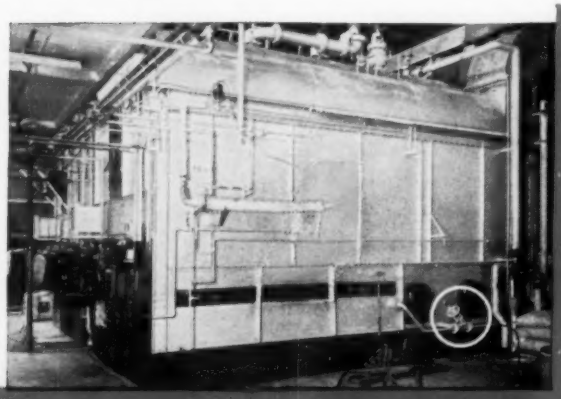
Yarway—known for nearly 50 years for *quality* blow-off valves—offers advanced design, dependable service, and reasonable cost . . . three features attractive to all boiler users.

The Yarway Seatless Blow-Off Valve, with balanced hollow sliding plunger and no seat to score, wear, clog or leak, is the most widely used valve for low and medium pressures.

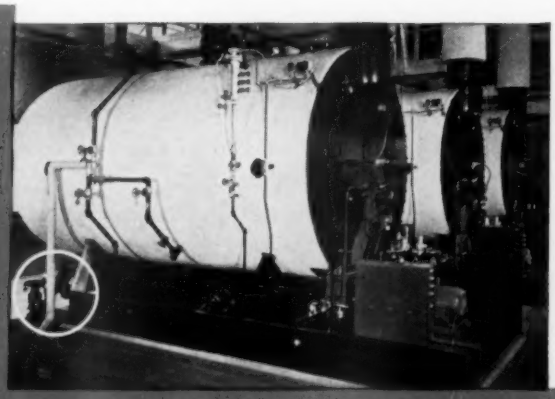
Specify Yarway Seatless Blow-Off Valves on your package boilers. All boiler makers will supply them.

For full description of Yarway Seatless Blow-Off Valves write for Yarway Bulletin B-426.

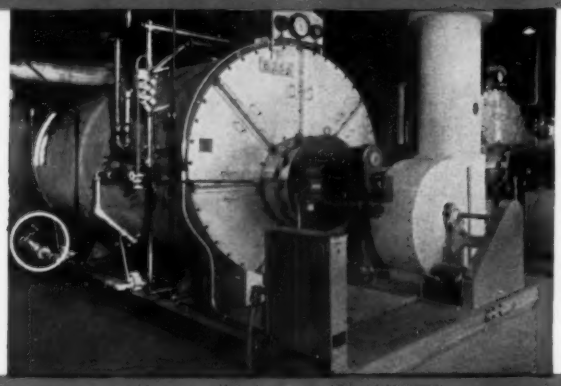
YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES



● ERIE CITY



● CLEAVER-BROOKS



● PREFERRED UTILITIES

● **Yarway Seatless Tandem Blow-Off Valve** (angle-straightway combination) with angle valve sectioned to show balanced sliding plunger design.

● **Yarway Seatless Tandem Blow-Off Valve,** angle-angle combination, straightway-angle or straightway-straightway tandems also available.

VALVES

For more data circle 506 on Post Card

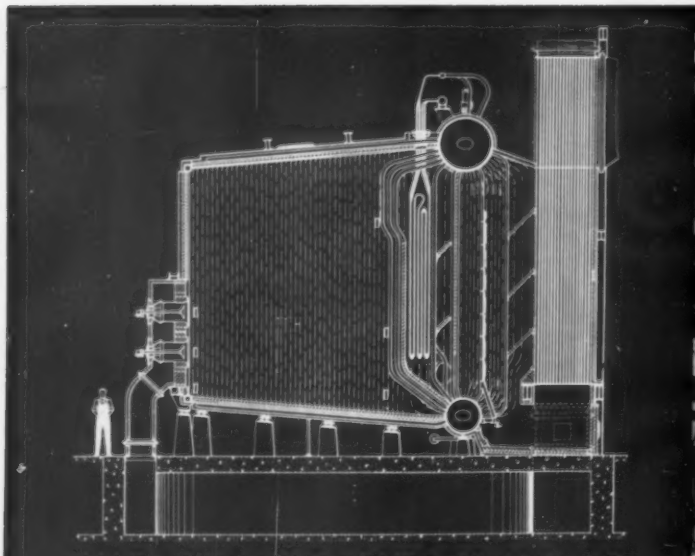
C-E Boilers exceed at

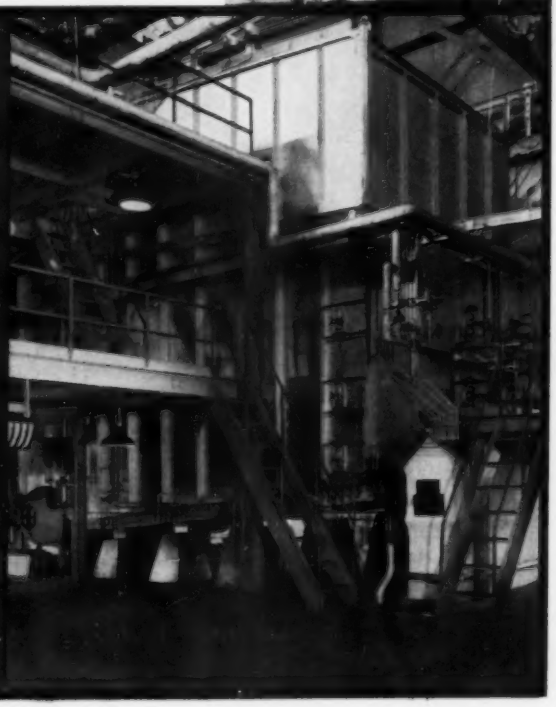
In a brewery, the demands placed upon its boilers can be rigorous indeed. At the Anheuser-Busch brewery in Newark, New Jersey, they provide steam for power generation, for processing and for numerous high-capacity instantaneous water heaters used in various brewing and bottling operations. Since brewing is essentially a "batch" process, steam demands fluctuate sharply and continuously. Yet the C-E Boilers installed at Newark have consistently exceeded performance guarantees and operate at an efficiency of 86%.

Mr. Herman Paradies, Superintendent of Utilities at the Newark brewery, has stated that it is not unusual for steam demands to rise from 80,000 to 130,000 pounds per hour in ten to fifteen seconds, and that the boilers have responded with nominal loss in pressure or temperature. This enviable record, which speaks well both for boiler design and for the skills of the power plant's operating management and staff, is one of which Combustion is proud.

When *you* need boilers, remember that C-E has a complete line of time-tested and service-proved designs and that there is a size and type which will fit your needs and serve you equally well.

C-164





(Right) One of the two C-E Type VU-50-B, oil-fired boilers in the Newark brewery (cross-section above). Each has a maximum continuous capacity of 100,000 lb per hr and produces steam at 550 psi and 750F. The floor in the foreground is chemically cleaned daily, polished twice weekly and completely refinished yearly.

guarantees Anheuser-Busch, Inc.

The Newark, N. J., brewery of Anheuser-Busch, Inc. The seven year old power plant, left, is so spectacularly clean and neat that it has constituted a major attraction for professional and technical groups along the eastern seaboard. The popularity of these tours is such that, currently, reservations must be made two months in advance.

COMBUSTION ENGINEERING

Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS; PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

For more data circle 507 on Post Card

College puts

coal at head of class

Otterbein College saves 42% with coal, installs revolutionary package boiler

Otterbein College, Westerville, Ohio, has discovered truly efficient heat generation. Otterbein's new heating plant burns coal in Coal-Pak boilers—developed by Bituminous Coal Research, Inc.—for automatic performance plus unique simplicity of operation. The result . . . savings in manpower . . . and a spotlessly clean plant.

In addition, comparative fuel cost studies have proved that coal costs 42% less per million Btu than the nearest competitive fuel in this area . . . a bonus savings! And, in keeping with the modern operation of this plant, the entire interior has been brightened by an attractive color scheme.

Facts you should know about coal

You'll find that bituminous coal is not only the lowest-cost fuel in most industrial areas but up-to-date coal burning equipment can give you 15% to 50% more steam per dollar. Today's automatic equipment can pare labor costs and eliminate smoke problems. And vast coal reserves plus mechanized production methods mean a constantly plentiful supply of coal at stable prices.

Technical advisory service

To help you with industrial fuel problems the Bituminous Coal Institute offers a free technical advisory service. We welcome the opportunity to work with you, your consulting engineers and architects. If you are concerned with steam costs, write to the address below. Or send for our case history booklet, complete with data sheets. You'll find it informative.

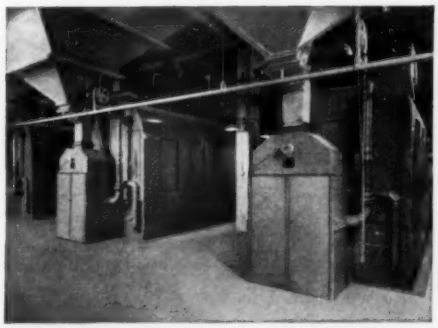
Consult an engineering firm

If you are remodeling or building new heating or power facilities, it will pay you to consult a qualified engineering firm. Such concerns—familiar with the latest in fuel costs and equipment—can effect great savings for you in efficiency and fuel economy over the years.

BITUMINOUS COAL INSTITUTE

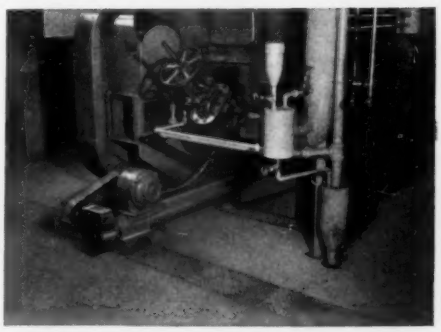
Department PE-08

Southern Building • Washington 5, D. C.

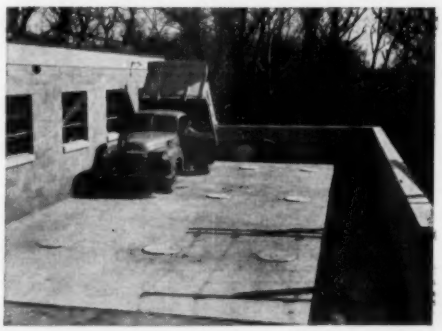


Heating plant at Otterbein showing the three Coal-Pak Automatic Water Tube Generators, by International Boiler Works Co. (Licensed under pending patents of Bituminous Coal Research, Inc.) Coal storage hoppers at top of photograph hold 30-35 tons of coal each.

Single switch on front of cabinet enables operator to change from "run" to "hold-fire" operations. Each generator has its own rugged, non-electronic combustion control system, housed in tamper-proof locked cabinet. It controls safely and efficiently the starting-up sequence, coal feed, fuel-air ratio, hold-fire operation and ash removal.



Rear of generator, showing part of dustless ash disposal system. Ash removal is an integrated feature of the package operation—no manual handling. Ashes are removed by screw conveyor. They pass into main screw conveyor recessed into the floor (covered by metal plate) and are carried outside.



Coal is delivered by truck and dumped through any of nine manholes into storage hoppers below. From hoppers, it is gravity fed into stokers. Four-foot wall around coal dumping platform permits use of platform for outside coal storage, holding additional 250 tons.

For more data circle 508 on Post Card

In the last two years...

All These Improvements

Whether your fly ash problems require a straight precipitator, a combination unit, or a mechanical collector alone, you can count on an economical solution from Research-Cottrell.

1. New Cyclo-trell—Sets new standards for collection efficiency and gas volume capacity. Double deck arrangement improves gas distribution to precipitator and conserves valuable space. Collecting tube is erosion resistant.

Cottrell Automation System—Higher "around-the-clock" collection efficiency, without manual adjustments. New electronic methods provide continuous optimum energization.

2. Opzel Collecting Electrodes—New design cuts cost, provides optimum precipitation zone with better gas flow and electrical conditions.

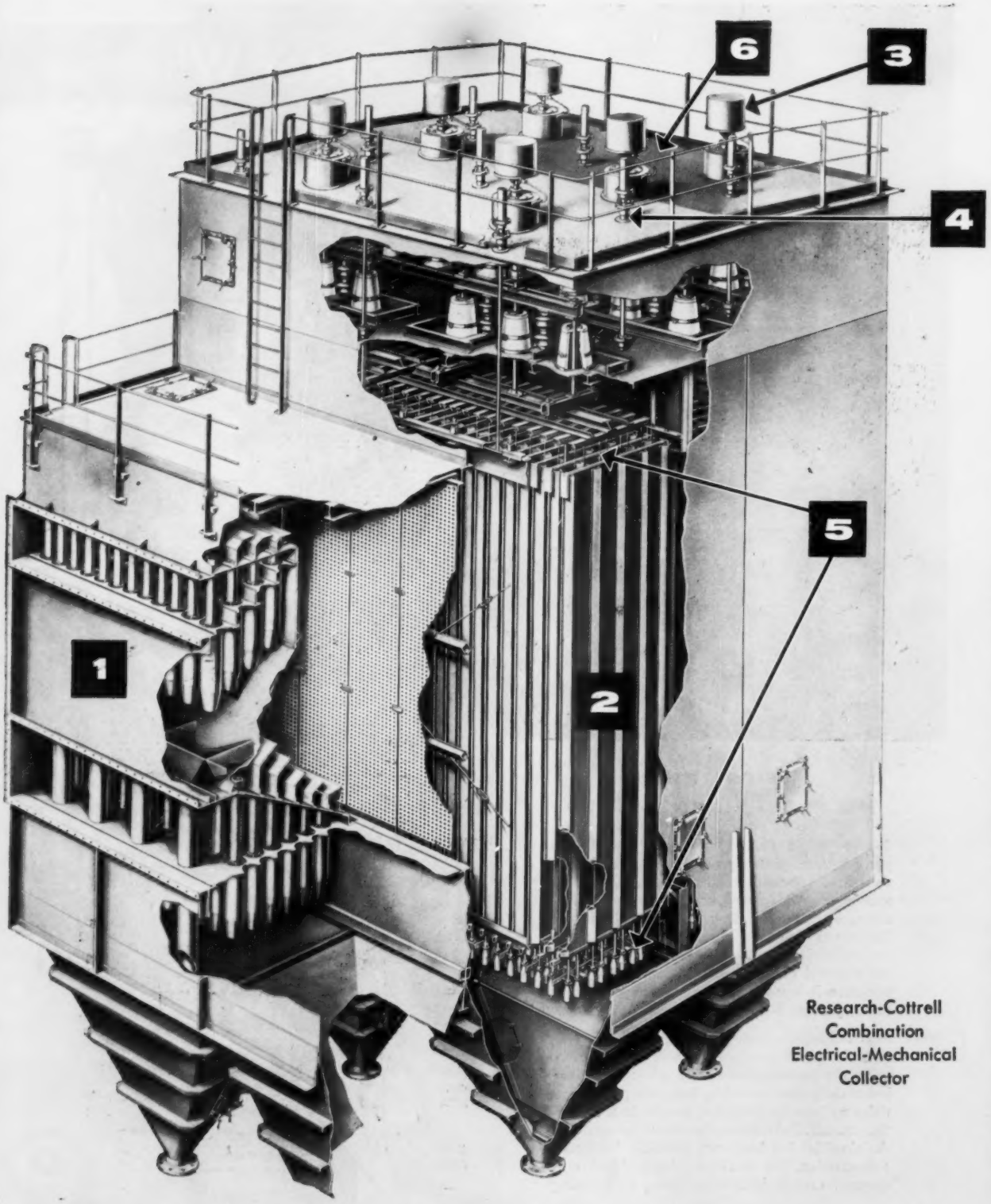
3. New Discharge Electrode Rappers—Available in air, electric, vibrating or impact type. Cycle and intensity are easily adjusted to maintain highest collection efficiency.

Silicon Rectifiers—New, hermetically sealed rectifiers last as long as the precipitator—without maintenance. Rectification efficiency is 96% to 99% with no voltage drop due to age.

4. M. I. Rappers on Roof—New arrangement provides better rapping and easier access to automatically controlled rappers, without additional expensive platforms.

5. New Discharge Electrodes—No. 430 stainless steel discharge electrodes are individually hung for easier access from top to bottom. Entire collecting plate surface is effective because the discharge wires extend well beyond the top and bottom of the plate.

6. New Top Constructions—Insulator compartments or steel housing over the entire roof are available. Designed for low insulator maintenance; bushings can be replaced without disturbing high tension frame. Top housing provides "out-of-weather" working space for maintenance.

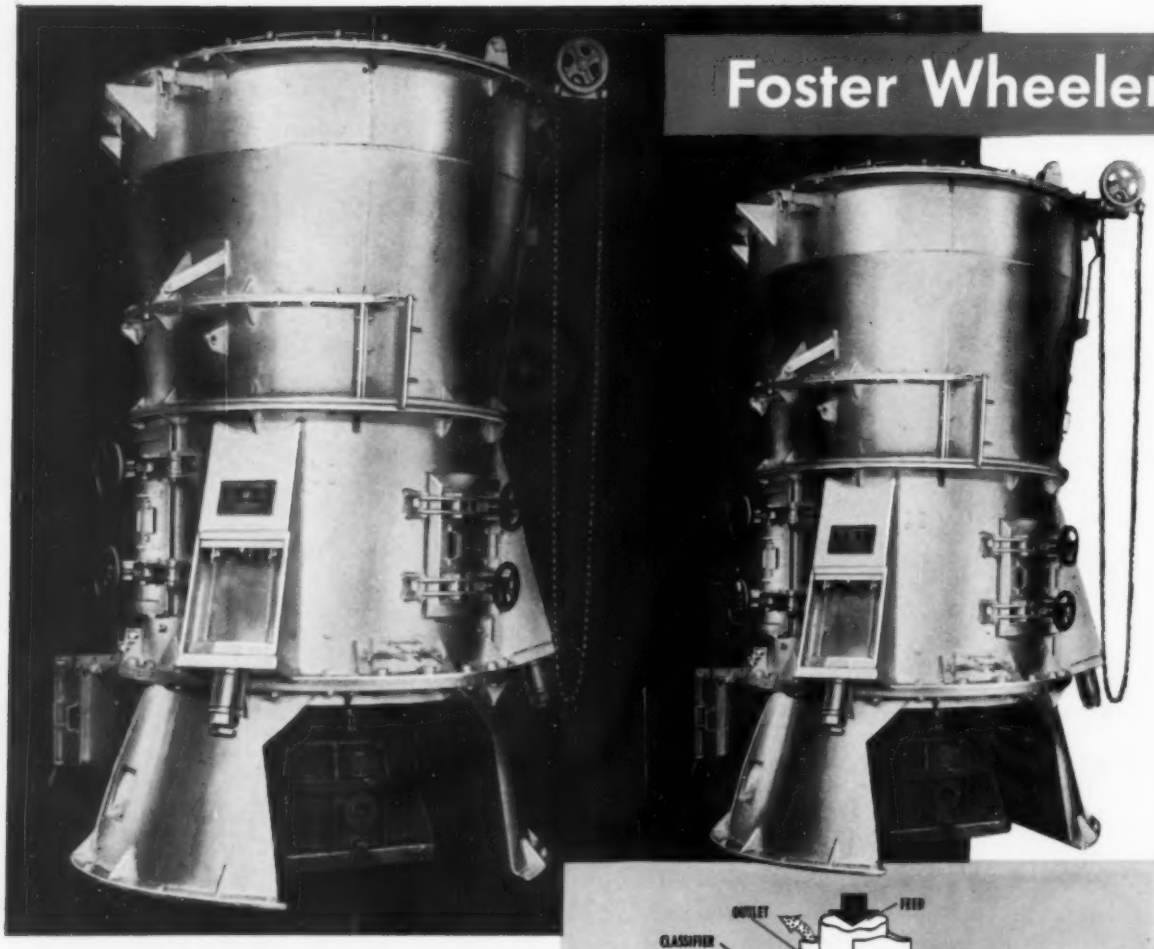


Research-Cottrell
Combination
Electrical-Mechanical
Collector

Research-Cottrell

RESEARCH-COTTRELL, INC. Main Office and Plant: Bound Brook, N. J. • 405 Lexington Ave., New York 17, N. Y. • Grant Building, Pittsburgh 19, Pa. • 228 N. La Salle St., Chicago 1, Ill. • 58 Sutter Street, San Francisco 4, Calif. • Research-Cottrell (Canada) Ltd., 33 Bloor Street East, Toronto 5, Ontario.

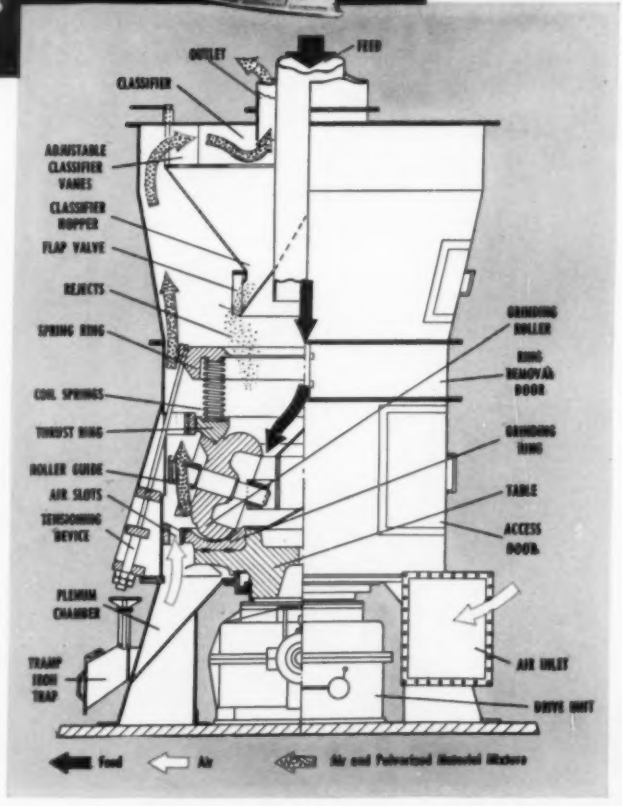
Foster Wheeler



HOW THE MB PULVERIZER WORKS

In the MB Pulverizer, grinding action takes place between a slowly rotating horizontal table and three spheroidal rollers, uniformly spaced around the table and loaded by the adjustable thrust of a large number of heavy coil springs. The power driven table causes the rollers to rotate while circling planet fashion and rolling over the material on the table. The rollers move up and down independently of each other as required to compensate for foreign matter in the charge.

The charge, entering the mill, is fed directly onto the grinding table, where it is crushed between the table and the rollers. Air entering from below the pulverizer table, floats the ground particles up into the classifier, located in the top of the housing. Particles too coarse to be carried to the classifier fall back onto the table for further pulverization. The classified pulverized fuel is discharged through the outlet at the top of the casing.



"MB" PULVERIZERS

offer proved advantages of

LOW POWER CONSUMPTION and LESS MAINTENANCE

Planetary Roll and Table Design, with 9 years of successful operating experience in Europe, now available in capacities up to 60 tons per hour

THE FOSTER WHEELER Type MB Pulverizer is a simple, compact, planetary roll and table mill for pulverizing solid fuels to commercial fineness with exceptionally low power consumption, low maintenance cost and high availability.

Introduced in Europe in 1949, this type of mill has now had nine years of service experience, with excellent performance records and outstanding economy of operation. Its proved advantages, summarized below, can contribute materially to important savings in the cost of pulverized fuel for large or small steam generators.

Low Power Consumption. Efficient grinding action results in unusually low power requirements per ton of capacity, assuring lower operating costs, year after year.

Low Maintenance. Extremely rugged construction and easy accessibility of all wearing parts reduce down-time for servicing. There are no bearings or lubricated parts subject to dust and heavy pressure. Grinding ring and rollers wear *slowly* and *uniformly* and can be easily replaced when required.

Uniform Product Fineness. Throughout the life of the grinding elements, uniform product fineness is readily maintained without loss of capacity.

Pressurized or Suction Operation. With all moving parts enclosed in a stationary, air-tight casing, the MB Pulverizer can be used for either pressurized or suction operation, providing complete flexibility for various types of firing service.

High Availability. All necessary adjustments for grinding pressure and particle size can be made externally while the mill is in operation, avoiding shutdowns except for periodic inspection or overhaul.

The type MB Pulverizer, with Foster Wheeler feeders, distributors, burners and fans or exhausters, provides a highly efficient and economical pulverized fuel system, supplementing the FW line of heavy-duty Ball Mill systems. For complete information, send for Bulletin MB-58-1. *Foster Wheeler Corporation, 666 Fifth Ave., New York 19, New York.*

FOSTER WHEELER

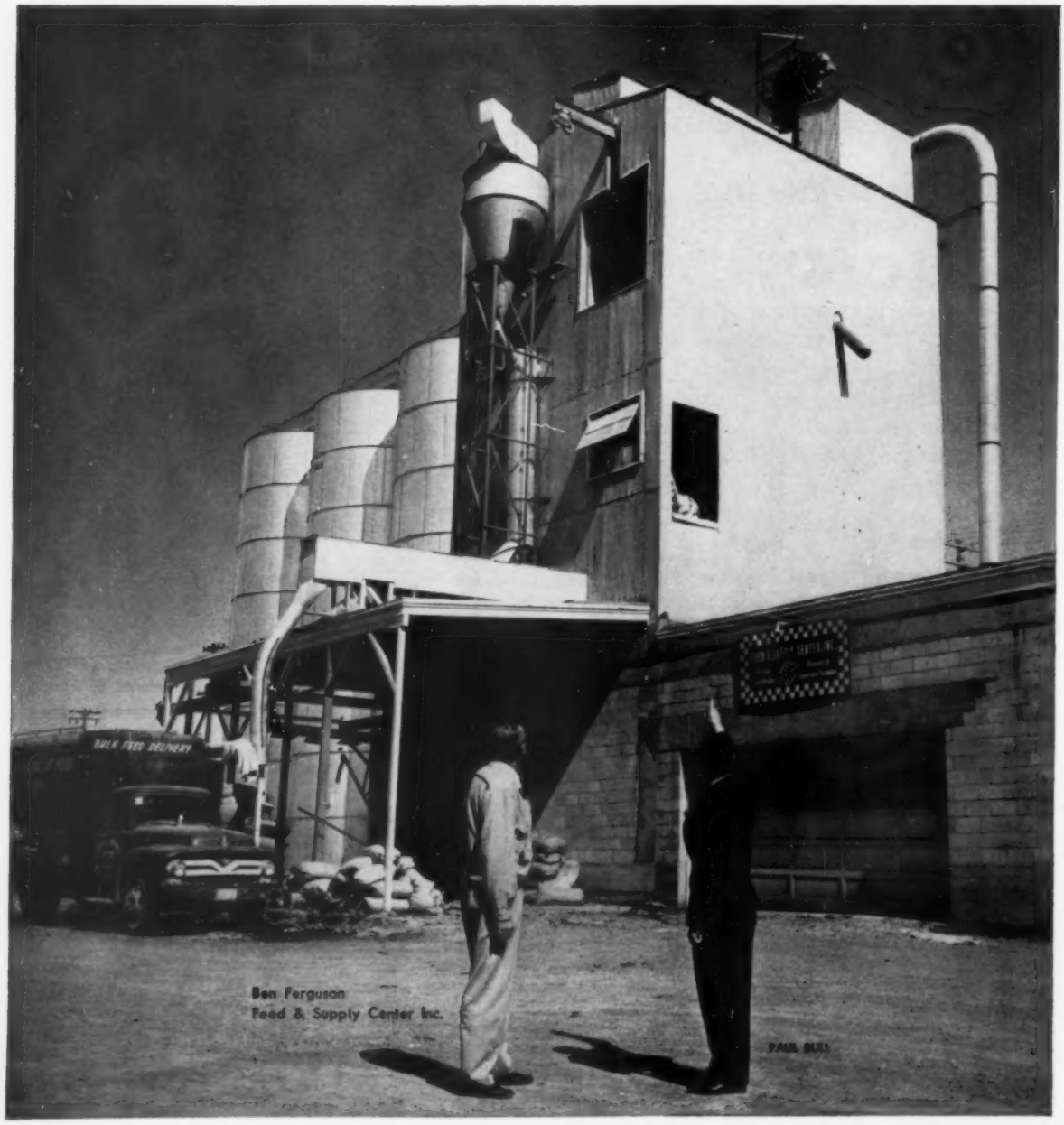
NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT.

For more data circle 510 on Post Card

"A bent shaft on an elevator motor might have caused a terrible accident

. . . if Fusetron dual-element Fuses had not shut down the motor"

PAUL M. BULL, Commercial,
Industrial Representative
Idaho Power Co., Twin Falls, Idaho



Mr. Bull continues:

"As a Commercial and Industrial Representative for the Idaho Power Co., I was asked to redesign the electrical work for the Feed & Supply Center Inc., Twin Falls, Idaho. The installation was handled by Detweiler, an electrical contractor.

"When the job was completed, Fusetron fuses kept blowing on a 15 hp., motor that operates the elevator.

"Larger size Fusetron fuses were tried and the result was almost disastrous.

"When the motor started the whole elevator shaft shook as if it would tear apart. Everyone was afraid that at any second the motor and apparatus would come crashing down the shaft.

"Fortunately, the Fusetron fuses opened and stopped the motor.

"A thorough check revealed that the shaft of the motor was bent in transit.

"If Fusetron fuses had failed to open to protect the motor, there might have been a terrible accident."

You too, can benefit by the 10 point protection of Fusetron fuses.

Fusetron dual-element fuses offer the safest, most complete electrical protection possible. With rare exceptions on commercial and industrial installations — ordinary fuses and circuit breakers protect only against short-circuits — but Fusetron dual-element fuses provide 10 point protection.

Why Risk Losses! One burned out motor . . . one needless shutdown . . . one destroyed switch or panel . . . one burned out solenoid . . . may cost you far more than replacing every ordinary fuse with Fusetron dual-element fuses.

BUSS Hi-Cap Fuses—High Interrupting Capacity above 600 and up to 5000 amperes

BUSS Hi-Cap fuses offer unlimited interrupting capacity for circuits of 600 volts or less. Their high speed operation on heavy shorts limits current to safe values. This minimizes damage to equipment and cuts down dangerous stresses on transformers.

These fuses can be coordinated with Fusetron fuses to isolate fault to circuit of origin.

BUSS Limitron Fuses — Limits Fault Current to Very Low Values

BUSS Limitron fuses have extremely fast opening characteristics to prevent heavy short-circuit currents from building up under fault conditions.

For more information write for —

Bulletin FIS *on Fusetron dual-element fuses.*

Bulletin HCS *on BUSS Hi-Cap fuses.*

Bulletin HLS *on BUSS Limitron fuses.*

Bussmann Mfg. Div.
McGraw-Edison Co.
University at Jefferson,
St. Louis 7, Mo.

Play Safe! install FUSETRON dual-element FUSES and BUSS Hi-Cap FUSES throughout entire Electrical System!

For more data circle 511 on Post Card

HOW THESE INSTALLATIONS

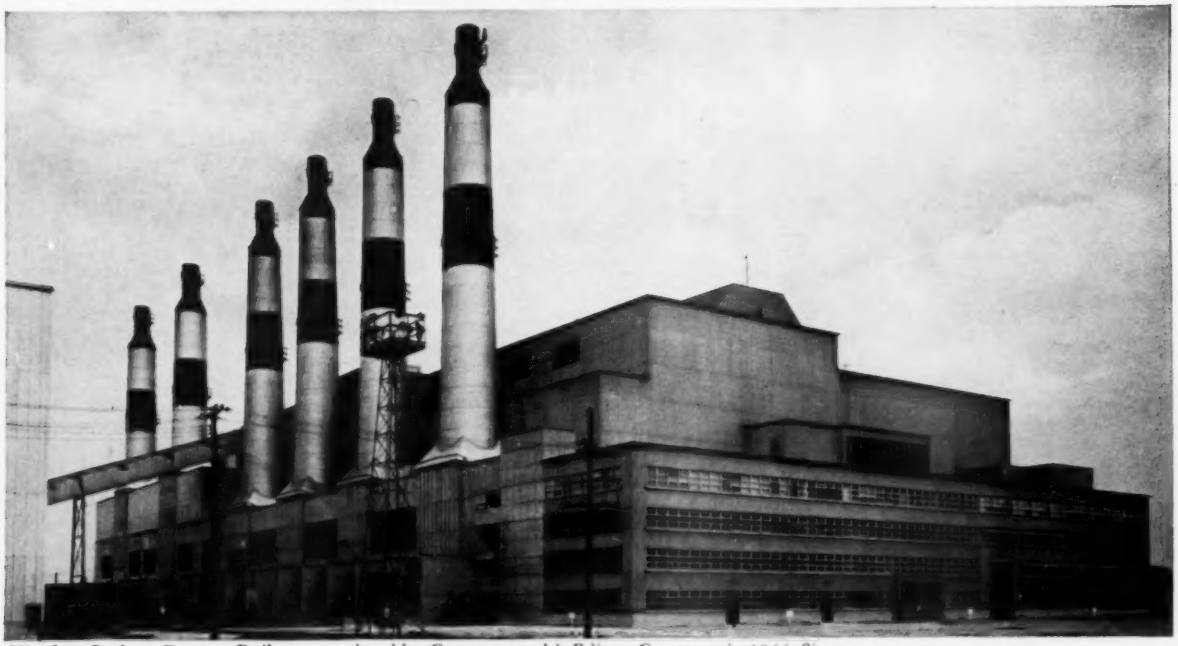
Jersey Central Power & Light Company's E. H. Werner Station. Here the success of the B&W Cyclone Furnace Boiler, the first installed in the East, has led to the purchase of two more boilers.

The B&W Cyclone Furnace...

A Modern, Economical Way to Burn Fuel for Power

Niles Station of Ohio Edison Company where two B&W Cyclone Furnace Boilers have been in operation since 1954.

UTILIZE LOW-GRADE FUELS



The first Cyclone Furnace Boiler was ordered by Commonwealth Edison Company in 1944. Since then this utility has purchased 15 more units, six of them for the Ridgeland Station shown here.

The B&W Cyclone Furnace simplifies the entire process of coal preparation, combustion, ash handling and ash segregation. Its cost-saving quality contributes to lower fuel costs and reduced maintenance as well as increased operational simplicity, flexibility and safety.

Although the B&W Cyclone Furnace operates simply and dependably on either oil or gas, it is particularly effective in utilizing inexpensive, low-grade coals. Its rapid combustion burns the coal more completely and operates with low excess air. Most of the ash is melted to slag right in the Cyclone Furnace, where it is easy to handle and dispose of. The slag cleaning and fly-ash problems so prevalent with other types of firing are consequently alleviated.

Many other modern advances in combustion and high-pressure, high-temperature steam generation are available through B&W. Write for further information today. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

PURCHASERS OF THE B&W CYCLONE FURNACE

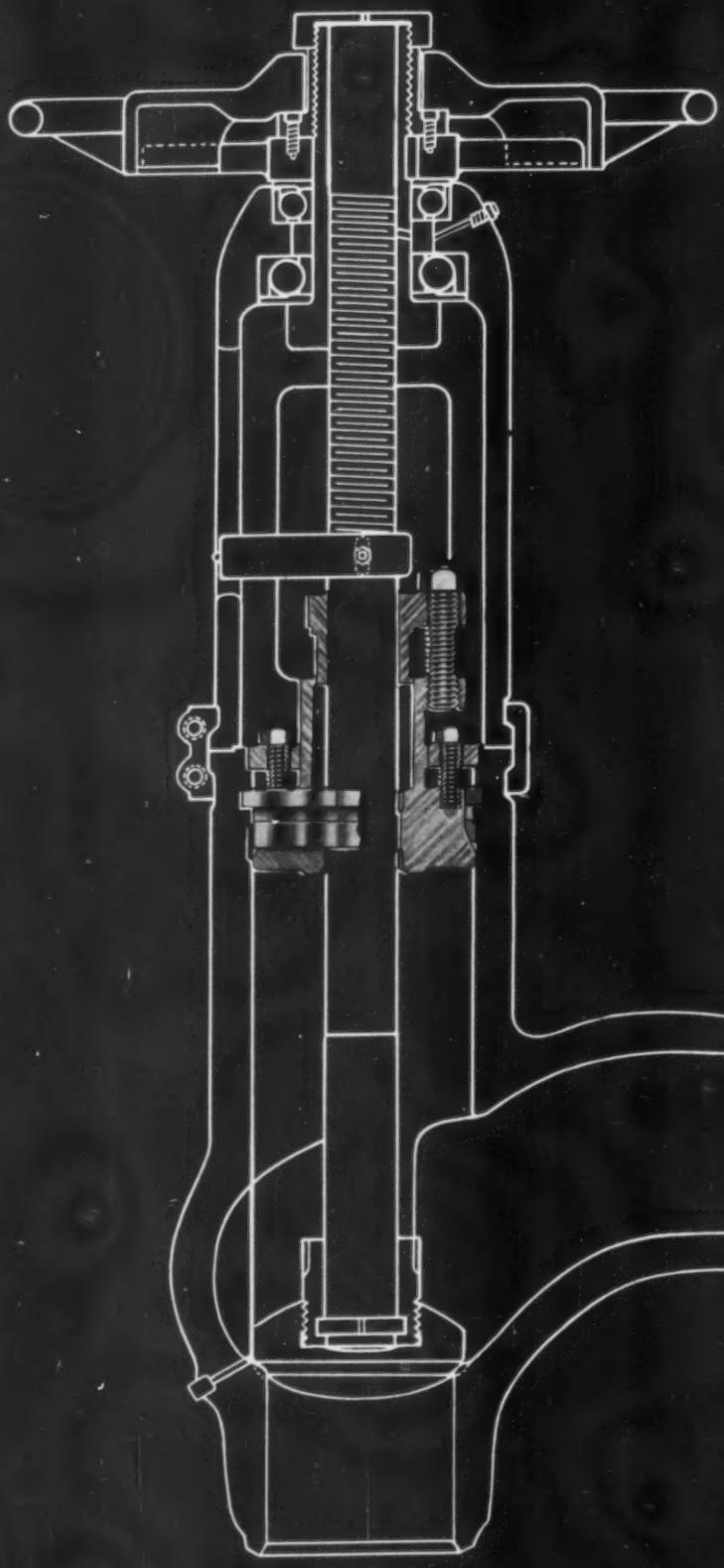
FOR CENTRAL POWER STATIONS	Number of Cyclone Furnace Boilers
Atlantic City Electric Co.	1
Baltimore Gas & Electric Co.	1
Chilena de Electricidad	2
Columbus & Southern Ohio Electric Co.	2
Commonwealth Edison Co.	16
Consumers Public Power District (Nebraska)	1
Detroit Edison Co.	1
Indiana & Michigan Electric Co.	1
Jersey Central Power & Light Co.	3
Memphis Light, Gas & Water Division	3
Middle South Utilities, Inc.	1
Missouri Public Service Co.	1
Monongahela Power Co.	1
Northern Indiana Public Service Co.	3
Ohio Edison Co.	2
Ohio Power Co.	6
Public Service Co., of New Hampshire	1
Tampa Electric Co.	3
United Illuminating Co.	2
Wisconsin Power & Light Co.	4
FOR INDUSTRIAL INSTALLATIONS	
American Cyanamid Co.	1
American Enka Corp.	1
Columbia Southern Chemical Co.	1
Consolidated Water Power & Paper Co.	1
Dow Chemical Co.	5
Eastman Kodak Co.	1
Greenwood Mills	1
International Paper Co.	4
National Container Corp., of Wisconsin	1
Rhinelander Paper Co.	1
St. Croix Paper Co.	1
Thilmany Pulp & Paper Co.	1
West Virginia Pulp & Paper Co.	1
Total	**75**

G-882

BABCOCK & WILCOX

BOILER DIVISION

For more data circle 512 on Post Card



EDWARD PRESSURE-SEAL ANGLE VALVE

What's New from Edward Valves

New Products . . . Problems and Solutions. . . Information on Steel Valves from Edward, Long-Time Leader in the Field!

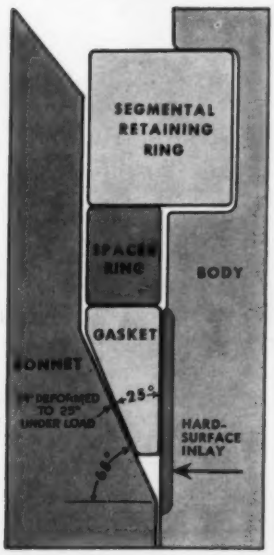
Not A Single Failure Reported In 5 Years

on unique "Pressure-Seal" body-bonnet joint!*

Advances in service temperatures (above 800 F) led to introduction, in 1945, of commercial steel valves with pressure-seal bonnet joint construction. These superseded bolted joint valves of earlier design.

The original 45° pressure-seal gasket, used by Edward and other manufacturers, was a significant improvement in minimizing leakage. But scientists in the Edward Research Laboratories refused to accept this as the best that could be done, set out to develop a better pressure seal joint.

In 1953 Edward research paid off: a completely new Edward pressure-seal design—with 25°–65° joint—was introduced. Design is shown in diagram on this page. The change in gasket angle, plus other Edward improvements described here, brought an end to bonnet joint leakage in pressure-seal valves.



Literally thousands of Edward pressure-seal valves have been installed since 1953 in a great variety of services. Of these, *not a single case of failure has ever been reported.*

Here's Why Edward Improved "Pressure-Seal" Succeeded:

SEALING AREA MULTIPLIED!
Improved gasket design *triples* sealing surface area, virtually eliminates possibility of leakage.

SEALING FORCE DOUBLED!
Angular relationship of bonnet, gasket and body directs more line load *outward* against the gasket, doubles sealing force.

SPECIAL GASKET SEAL-COATING!
A special corrosion-resistant malleable coating (.001 inch thick) is applied to gasket, flows into minute irregularities, assures perfect seal.

IMPROVED BODY SEALING SURFACE!
Possibility of any microscopic casting porosity in vital body-gasket sealing zone is avoided by inlay of corrosion resistant hard-surfacing material.

EASY DISASSEMBLY!
Body bore has been enlarged just above gasket area; this permits gasket to be easily lifted out, after segmental retaining ring and spacer are removed.

GASKET DAMAGE ELIMINATED!
Sharp edge of gasket has been rounded-off, eliminates possible damage to gasket during handling or storage.

EDWARD VALVES, INC.
1202 West 145th Street, East Chicago, Indiana
Subsidiary of
ROCKWELL MANUFACTURING COMPANY

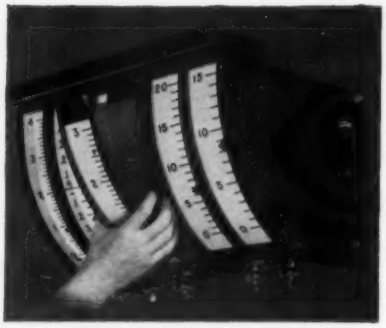
Represented in Canada by
LYTLE ENGINEERING SPECIALTIES, LTD., 360 Notre Dame St. W., Montreal 1, Que.

Edward builds a complete line of forged and cast steel valves from ¼" to 18"; in globe and angle stop, gate, non-return, check, blow-off, stop-check, relief, hydraulic, gage and special designs; for pressures up to 10,000 lbs; with pressure-seal, bolted, union or welded bonnets; with screwed, welding or flanged ends.

*T. M. Reg. U. S. Pat Off.

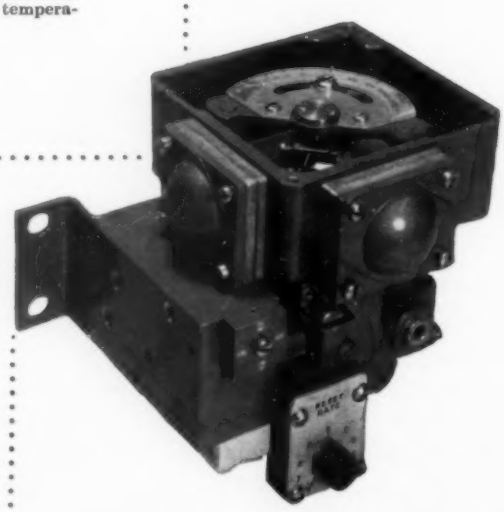
For more data circle 513 on Post Card

REPUBLIC BOILER METER provides, in one instrument and on one chart, all information essential to efficient boiler performance. Indicates, records and integrates steam flow from boiler and records rate of air flow for combustion. When air is correct for best combustion, air flow record coincides with steam flow record, regardless of boiler load. A third element can be added to record flue gas temperature or steam pressure. Write for Bulletin 420.

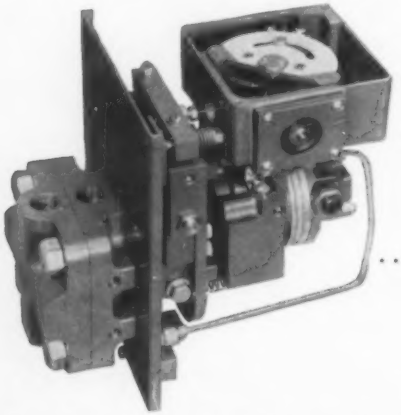


REPUBLIC MULTI-POINT GAUGES have 12-inch scales to measure draft, pressure, differential pressure and temperature. These highly-accurate gauges are sturdy and dependable, easy to maintain and simple to adjust. Suitable for flush or semi-flush mounting. Write for Bulletin 58-12.

REPUBLIC V5 SERIES GAUGES match the performance of much larger gauges, yet require only one-fourth the panel space. These compact instruments measure draft, pressure, differential gas pressure and temperature. May also be used with pneumatic transmitters to indicate flow, liquid level, temperatures and pressures. Suitable for individual or multiple mounting. 5-inch illuminated scales. Full sized measuring elements. Duplex units available. Write for Bulletin 806.



REPUBLIC TYPE VC PNEUMATIC CONTROLLER is designed for use with transmitters having an output of 3-to-15 psig; its own output is identical. Available with pneumatic or spring loaded set point. Proportional band adjustable from 2% to 500%. Reset adjustable from 0.1 to 50 repeats per minute. Dead band is less than 0.05%. Write for Bulletin 57-2.

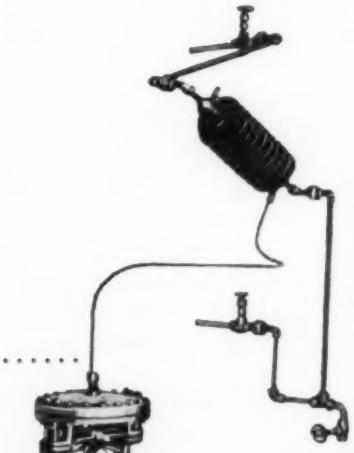


REPUBLIC VDP PNEUMATIC DIFFERENTIAL PRESSURE TRANSMITTER is ideal for steam flow measurement. Has extremely wide range adjustment (20-to-1) without parts change or zero setting adjustment. Accuracy within 1% of top scale value. Special non-bleed pneumatic amplifier has low air consumption (less than 0.2 scfm), high output capacity (1.0 scfm) and high gain. Companion model: low-static, low differential pressure, ideal for measuring combustion air flows. Write for Bulletin 58-11.

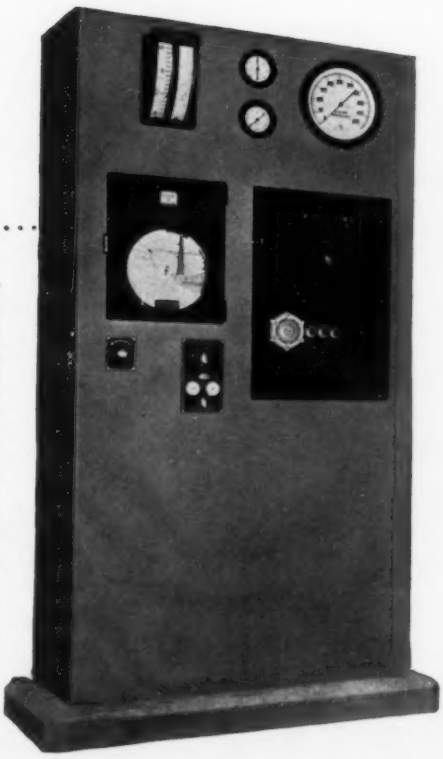
REPUBLIC SERIES 77S FINAL DRIVE UNIT is a powerful final link for positioning valves, dampers, etc. This compact unit can be installed horizontally or vertically, indoors or out. Drive lever mounts on either end of the shaft. Local manual positioning provided for in the event of air failure. Quick response without hunting is inherent in design. Proportionality of signal response can be tailored by cam shaped on the job. Write for Bulletin 56-3A.

CUT STEAM COSTS

with REPUBLIC INSTRUMENTS and CONTROLS



REPUBLIC TYPE FW-1 THERMO-HYDRAULIC FEEDWATER CONTROL SYSTEM. Automatically regulates water level in boilers to 600 psig pressure, and with ½-inch to 4-inch diameter feed lines. Needs no outside source of power. Simple, rugged system consists of pressure generator, regulating valve and connecting tubing. All components accessible for simple maintenance needs. Write for Bulletin 56-2.



REPUBLIC AUTOMATIC COMBUSTION CONTROL SYSTEM PANEL. This one controls a 15,000 lbs/hr gas-fired package boiler supplying 235 psi steam. System features on/off and modulating operation, and flame failure control. Instruments include Republic 2-Unit Draft Indicators and Type EST Boiler Meter with Flue Gas Temperature Pen.

Republic systems automatically maintain constant steam pressure by controlling heat input to boiler in balance with boiler load. They automatically maintain highest combustion efficiency by controlling fuel and air input simultaneously, and automatically maintain any desired load division.

Whether you operate package boilers or a central station, low steam costs depend upon accurate regulation of fuel, air and feedwater in terms of immediate steam demand. Republic has pioneered in cutting those costs since the early 1900's.

From this half-century of experience has come a complete line of carefully engineered components, and complete systems for every phase of steam production, regulation and measurement. Shown here, for example, are just a few of the Republic instruments and controls that can cut steam costs in a package boiler installation.

But there's more to it than that. Really efficient steam production demands that these instruments and controls be correctly applied. Republic can help you. We place at your disposal years of practical engineering experience with steam plants of all sizes . . . all pressure and temperature ratings . . . all load characteristics.

To get the facts you want, contact your nearest Republic sales office; they're located in principal cities throughout the United States and Canada. Or, write to...

REPUBLIC
FLOW METERS CO.

Subsidiary of ROCKWELL MANUFACTURING COMPANY
2240 DIVERSEY PARKWAY CHICAGO 47, ILLINOIS
In Canada: Republic Flow Meters Canada, Ltd.—Toronto
Manufacturers of electronic and pneumatic instrument and control systems for utility, process and industrial applications.

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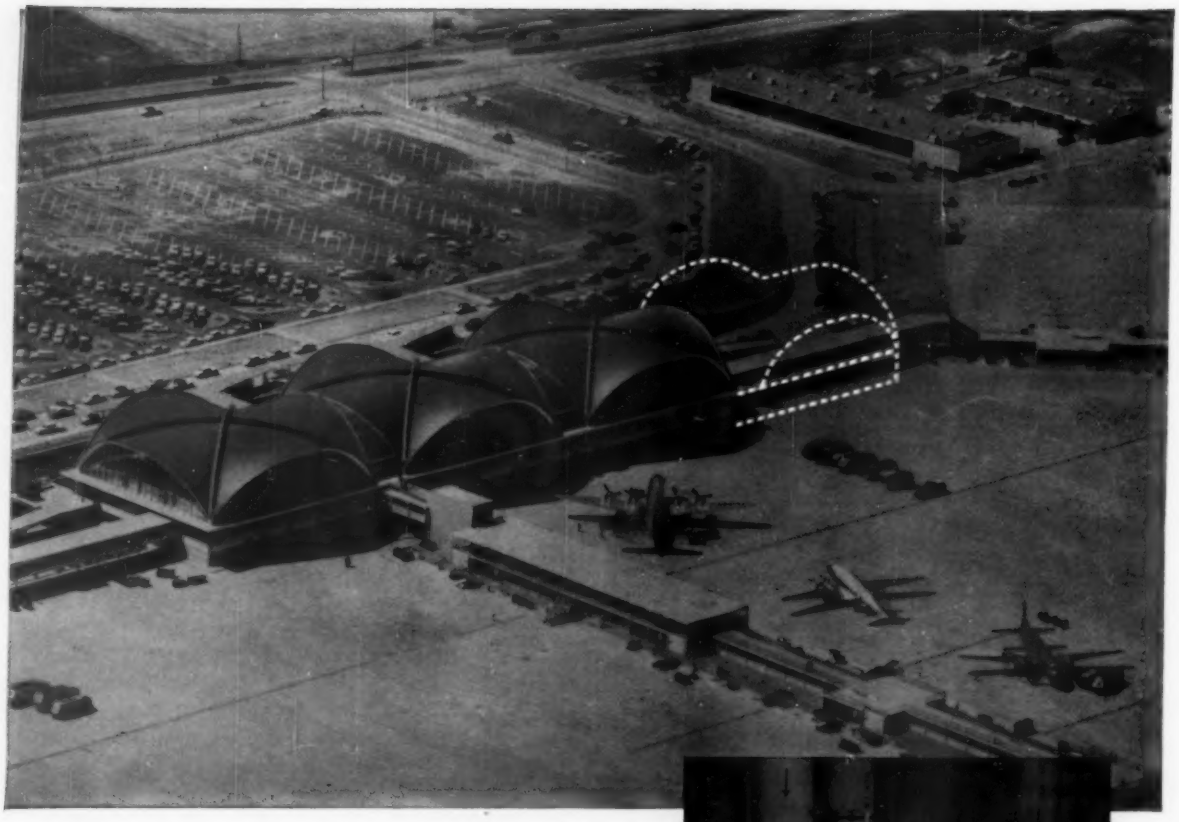

Nalco protects vital services of new LAMBERT-ST. LOUIS AIRPORT

Functional efficiency is usually one of the hallmarks of fine architecture and it is apparent throughout the new St. Louis Municipal Airport Terminal Buildings.

Vital service facilities are housed in a low, clean-lined power plant, well separated from the present main terminal building in anticipation of planned expansion to accommodate increasing airline traffic. The Nalco System protects boiler and cooling water systems by effectively controlling scale, corrosion and microbiological growth . . . a non-architectural supplement to functional efficiency in *any* plant where water is used.

Whether you are planning a new plant, or modernizing an old one, call on Nalco for water treatment chemicals and services that consistently produce outstanding results.

Top photo: Unusual modern architecture of St. Louis Municipal Airport Terminal Building is expandable in any direction. New units (dotted lines), can be added readily when required. Services buildings, *upper right*, are built and equipped with future expansion in mind. *Photo by Lloyd Spainhower.*

Lower photo: Nalco Chemicals and Services protect both boiler and cooling water systems at new St. Louis Airport. In this photo a Nalco cooling water treatment, supplied in ball briquette form, is being applied through the convenient Nalco feeder.

NATIONAL ALUMINATE CORPORATION
6224 W. 66th Place • Chicago 38, Illinois

CANADA: Alchem Limited, Burlington, Ontario
NORTHWESTERN UNITED STATES, HAWAII and ALASKA:
The Flox Company, Inc., Minneapolis 3, Minnesota
ITALY: Nalco Italiana, S.p.A.
WEST GERMANY: Deutsche Nalco-Chemie GmbH
SPAIN: Nalco Espanola, S.A.

THE Nalco® SYSTEM . . . *Serving Industry through Practical Applied Science*

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HELPFUL BULLETINS

LIGHTING, COMMUNICATION

101 Lighting Specifications — The 1958 edition of the RLM Standard Specifications Book is a 40-pp reference guide on industrial lighting units. In it, specifications for fluorescent and incandescent fixtures most widely specified have been strengthened in areas of efficiency, design and construction quality. New specifications include two-and-three-lamp special service fluorescent lamps, other. Technical data has been simplified by incorporating all specifications pertinent to all fixtures into a new single "Specification 101." RLM Standards Institute.

102 Fluorescent Ballasts — Bulletin GEC-983L 20 pp, gives prices and data on various types of ballasts for fluorescent lamps. Included are a quick guide to ballasts, descriptive tables, cross section dimension diagrams, chart for suggested replacement of obsolete ballasts, installation and operating instructions and wiring diagrams. General Electric Co.

103 Mobile Radio — "Under the Influence of Radio" is a 16-pp guide for prospective users of mobile radio equipment. Includes information on licenses for base stations and mobile units and for drivers. Also gives instructions on adjustments, how to send a message, and maintenance. General Electric Co.

LUBRICATION

104 Lubrication Equipment — Fully illustrated, 32-pp Catalog 65 covers design and engineering features of air-motor operated lubricant pumps and allied equipment. Complete with lubricant-output-performance and selection charts, catalog fully details advantages and applications of this equipment. Lincoln Engineering Co.

105 Guide to Lube Use — Bulletin 116 is a little 8-pp guide showing where and how Molykote lubricants should be applied. Chart indicates equipment on which the lubricant promises to perform well, method of applying it and benefits to be expected. The Alpha-Molykote Corp.

PUMPS, COMPRESSORS

106 For General Service — Described in Catalog D-100 are pumps for hot and cold water and brine circulation, air conditioning systems, sprinkler systems, boiler feeding, pressure boosting and washing machinery. Cutaway drawings are provided, and mechanical features illustrated. Performance data and sizes are included, as well as material specifications. C. H. Wheeler Mfg. Co.

107 Centrifugal Fire Pumps — Three types of fire pumps — horizontal single stage, horizontal multi-stage and vertical turbine multi-stage pumps — are covered in illustrated, 32-pp Bulletin B-1500. Featuring complete descriptions and dimensions on the horizontal centrifugal pumps and the vertical turbine multi-stage types, bulletin contains data pertinent to selection, application and installation of fire pumps for all types of commercial and industrial risks. Schematic charts are included. Peerless Pump Div., Food Machinery and Chemical Corp.

108 High Pressure Compressors — Eight-pp Bulletin A-93 provides information on heavy-duty high pressure stationary compressors. Includes specifications on four basic high pressure models. Installation photos, sectional drawings and charts deliver complete story on the compressors which are designed for such purposes as soot blowing chemical processing and gas compression. Joy Mfg. Co.

ELECTRICAL

110 Protected Motors — Bulletin GEA-6721 describes company's weather-protected motors available from 250 hp and up for both indoor and outdoor operation. Main features and advantages are illustrated. General Electric Co.

111 Enclosed Short Motors — Bulletin 2100 describes company's enclosed Pancake motors intended for use on machine tools, roof-ventilating fans and other space-cramped applications. Cutaway view showing construction features is included, as well as specifications. The Louis Allis Co.

112 Improved TEFC Motors — This company's redesigned line of TEFC tube-type motors with capsule-mounted split-sleeve bearings are described in Bulletin 51B8991. They are available in standard and explosion-proof designs from 40 hp at 600 rpm through 800 hp at 3600 rpm. Bulletin shows the motor's tube-type air-to-air heat exchanger system, bearing construction, frame, stator and rotor features. Allis-Chalmers Mfg. Co.

113 Secondary Substations — A comprehensive description of secondary unit substations from simple radial systems to secondary selective systems is contained in 20-pp Bulletin 18B6285C. Includes an incoming line section with tabulated data, a transformer section with ratings table, a distribution feeder section, space requirements of secondary unit substations, and an applications section. Allis-Chalmers Mfg. Co.

114 Transformer Guide — Bulletin GEC-1600, 20 pp, is a quick and easy guide for specifying and ordering dry-type transformers for commercial and industrial applications. Transformer types are shown in a pictorial index which also lists applications and gives a basic description of each unit. General Electric Co.

115 Service Entrance Cable — This 8-pp booklet gives availabilities, technical data, material economies and advantages of aluminum service entrance cable. Chart furnishes pertinent cable construction details, dimensions, weights, and current carrying capacities. Typical applications are also covered. Kaiser Aluminum & Chemical Sales, Inc.

116 Distribution System — This bulletin describes the Masterguard, a prefabricated electrical distribution system. Shows how it performs the three functions of a distribution system: transmission of power, protection and control. Plug-in devices, service entrance equipment, Uni-Bus centers and control equipment are covered; safety, convenience noted. Electric Distribution Products, Inc.

117 Improved Conductor — Applications and advantages of all-aluminum alloy conductors for distribution systems are detailed in this 8-pp brochure. Selection charts and other data are included. Kaiser Aluminum & Chemical Sales, Inc.

118 Conduit Fittings — Catalog C-58, 28 pp, illustrates conduit fittings and accessories, including new pressure cast EMT connectors and couplings. Provides data on fittings for rigid conduit, for armored cable, flexible metallic tubing and non-metallic cable, and for service entrances. Handy chart shows recommended fittings for wire and cable sizes. Conduit Fittings Corp., Div., U. S. Industries, Inc.

119 Electrical Equipment — Twelve-pp Bulletin 2706 covers, briefly, this company's electrical products and manufacturing facilities. Emphasis is on variety of equipment available: Condulet electrical equipment, floodlights, other product lines. Installation photos show these in use. Crouse-Hinds Co.

120 Master Switches — Eight-pp Bulletin 5701A presents design features and engineering data on master switches available in many circuit combinations from one through five speeds, forward or reverse direction. Contains voltage ratings, application photos, contact arrangements and action, outline diagrams, prices. Furnas Electric Co.

121 Capacitor Equipments — Bulletin GEA-6796, 8 pp, describes aluminum stack racks designed to supply bulk kilovars on transmission, suntransmission and distribution circuits. It provides detailed information on selection, application, installation and protection of stack rack capacitor equipments. Includes charts, dimensional drawings and tables on ratings and weights, performance characteristics. General Electric Co.

122 Improved Breakers — Sixteen-pp Bulletin SD-100 describes QO circuit breakers for industrial, commercial, institutional and other applications. Gives detailed information on features of these quick-make, quick-break circuit breakers, also covers load centers and panelboards. Tables and specification guides are included. Square D Co.

Postage-free cards for ordering bulletins are on pages 127—8. You may also use the cards to order literature mentioned in the ads.

123 Storage Batteries — Bulletin 210, 24 pp, is a detailed technical manual on use of stationary storage batteries. Contains reports on effect of temperature on battery capacity and provides tabulated data and general information on selection of batteries and charging equipment, battery and charger maintenance, selection of battery racks, determination of discharge ratings. Exide Industrial Div., The Electric Storage Battery Co.

. . . Reference Data on Electrical Insulation

124 Electrical Insulation — Catalog 24 contains 16 pp of information on electrical insulation products, including packaged cuffed coils, hard maple wood wedges, formed fibre wedges and fibre washer assortments. Includes descriptive details, specifications, dimensional data and price tables. Insulation Manufacturers Corp.

125 Butyl Rubber Insulation — Contained in this 28-pp illustrated book is an analysis of the chemical structure of butyl insulation. Charts and technical listings in table form provide data on electrical qualities, heat serviceability, temperature resistance and aging properties. Details of cable construction, typical types of butyl insulated cable, and facts on shielding included. National Electric Products Corp.

126 Insulating Materials — Bulletin GER-1467, 12 pp, describes in text, tables and pictures the characteristics and application range of insulating materials which are chemically, physically and electrically compatible. Includes technical data on available products, including mica, mat, varnished cloth and papers, insulating varnishes, wire enamels, Irrathene irradiated polyethylene, others. General Electric Co.

VENTILATING AND AIR CONDITIONING

127 Air Handling Units — Complete engineering information on company's low pressure sprayed coil and high pressure dry and sprayed coil climate changers is incorporated in 56-pp Bulletin PB-290. Detailed descriptions and illustrations on the all-purpose air conditioners for commercial and industrial comfort and process applications are included. The Trane Co.

128 Vapor Condenser — Bulletin 139R describes company's sectional Aero vapor condenser. Illustrated with photos and diagrams, expl ins functions of the condenser and provides capacity curves for eight sizes, and a table of dimensions and weights. The machine is designed to condense vapors in a closed system. Niagara Blower Co.

129 Liquid Cooler — Bulletin HB-258, 16 pp, describes package liquid coolers for use in space cooling systems, combination heating and cooling systems and for industrial processes requiring controlled cooling of materials. Design features, typical installations and a detailed description of components are included. Bell & Gossett Co.

INSTRUMENTS AND CONTROLS

131 For Metering — Two especially accurate and economical meters, the Propeloflo for liquids and the Shuntflo for air, steam or gases are the subject of 6-pp Bulletin 100-R1. Provides photos, line drawings, cutaway views and technical data tables to supplement the explanatory text. Builders-Providence, Inc., Div. B-I-F Industries, Inc.

132 Pulsation Threshold — "A Practical Pulsation Threshold for Flowmeters" is the subject of 10-pp Bulletin 91-117. Defines pulsation and discusses magnitude of a pulsation error, how pulsation effects can be eliminated, what types of flowmeter are least affected, and how accurate corrections can be made. Fischer & Porter Co.

133 Flow Indicators — Bulletin 18W describes flow indicators for pipeline installation, applicable to liquids and gases as well as vapors and slurries sufficiently translucent for observation of indicating components through sight windows. Three types are described. Also given is information on sizes, materials of construction, minimum flows indicated, and pressure and temperature ratings. Schutte and Koerting Co.

134 Bellows Flow Meter — Specification S-292-2 describes construction and operation features of company's bellows meter for flow and liquid level applications. Included is cutaway view showing component features, specification data. Minneapolis-Honeywell Regulator Co.

135 Gravimetric Feeders — Simplex or duplex gravimetric feeders for liquids or solids are described in 8-pp Bulletin 32-R2. Provides explanatory text, dimensional drawings and tables, photos, schematic drawings and performance charts. Omega Machine Co., Div., B-I-F Industries, Inc.

136 Viscosity Control — This leaflet is a report on the results of actual operation of the "viscorator" for maintaining fuel oil at the proper viscosity, and the procedures for cleaning burner barrels and tips fully assembled. Diagram shows installation. Fischer & Porter Co.

137 Thermocouple Assemblies — Twelve-pp Section E describes heavy duty industrial thermocouple assemblies. Each component in the thermocouple assembly is individually described, and selection data, photos and dimensional diagrams are included. Thermo Electric Co., Inc.

138 Remote Valve Controls — Bulletin 5811 is a 20-pp design booklet on manual remote valve controls. Provides information on flexible shaft valve controls, including valve couplings and remote operating terminals. Also shown are standard reach rod controls including universal joints, valve couplings, and remote stations. Company's new 300-deg swivel geared joint is also shown. Stow Mfg. Co.

139 Valve Actuator — Catalog V-200 describes an automatic valve actuating conversion unit designed for converting hand-operated valves to automatic operation. Advantages are detailed and a drawing showing design features included, as well as maximum differential chart. C. H. Wheeler Mfg. Co.

WATER, WASTE TREATING

140 Foam Control — Bulletin HSP-905 describes company's antifoams used to control foaming and carryover in steam boilers, eliminate unscheduled outages, cut maintenance, simplify control, minimize blowdown and make-up, and disperse sludge. Case histories are detailed. Hagan Chemicals & Controls, Inc.

141 Distilling Equipment — This 8-pp bulletin describes operating principle of company's thermocompression distilling equipment for economical production of fresh water from sea water and concentrates from industrial liquors. Illustrates numerous models and installations, and gives dimensions and weights. Mechanical Equipment Co., Inc.

142 Sewage Treatment — This 20-pp catalog contains engineering drawings illustrating typical piping arrangements in sewage treatment plants. "In operation" and "in construction" photos of existing sewage plants show 31 ways to accelerate construction and to provide low-cost maintenance. A complete table of sizes and specifications for company's steel couplings is another feature. Dresser Mfg. Div., Dresser Industries, Inc.

VALVES AND FITTINGS

144 Control Valves — Digest Catalog 58 is a 20-pp quick reference on control valves defining control of air power and its applications. Valves are listed by function rather than by series. It includes an information section on fundamentals of pneumatics and various applications of compressed air. Ross Operating Valve Co.

145 Bronze Valves — Catalog 158, 12 pp, describes bronze valves for a variety of industrial and other applications. Separate sections are devoted to heavy duty valves, heating specialties, and solder joint valves. Dimensional information and comparison chart included. Hammond Brass Works.

146 Solenoid Valves — Eight-pp Factory Stock List No. 505 contains prices, valve ratings, flow diagrams, illustrations and engineering data on solenoid valves. Sufficient ordering information is provided. Automatic Switch Co.

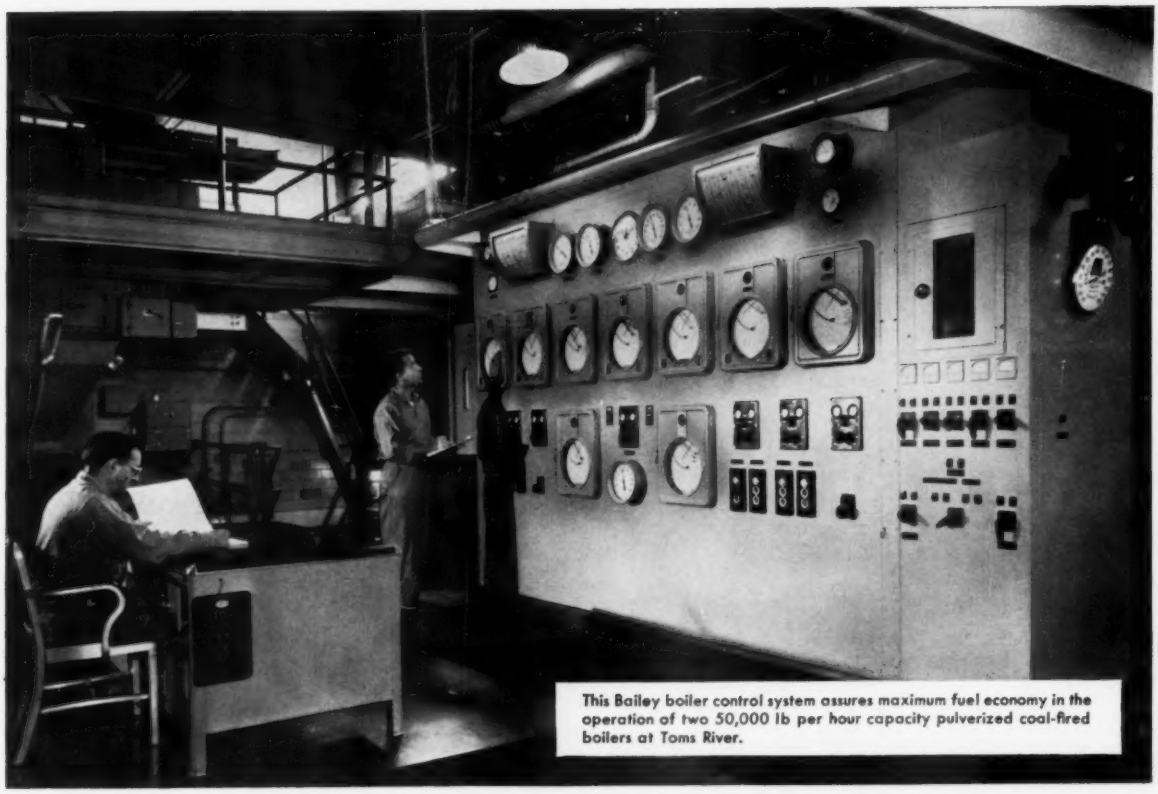
147 On Tube Fittings — Catalog 056, 20 pp, covers straight-thread hydraulic tube fittings. Gives engineering details plus ordering and installation instructions on the line which includes elbows, tees and plugs in a variety of combinations. Engineering drawings of each type are included along with a table of dimensions for each size. Available taps and counterbores are also featured. Flodar Corp.

148 Pipe Fittings — Eight-pp Catalog 2-PF gives data on ductile iron pipe fittings, including typical applications, prices, safety factors and service ratings. Also gives comparative physical properties of pipe fitting metals. Provides data on impact testing. Fittings covered include pipe lock couplings, screwed and flanged fittings and companion flanges. The Kuhns Brothers Co.

149 Loading Assemblies — Catalog F-32R, 24 pp, describes loading assemblies and accessory products. Contains detailed product descriptions and photos, engineering information, dimensional drawings, installation layouts and selection instructions. Jordan Industrial Sales Div., OPW Corp.

MECHANICAL POWER TRANSMISSION

150 Adjustable Speed Drives — Packaged adjustable speed drives designed for converting alternating current to direct current are described in 14-pp Bulletin EN-64. Includes sketch of operation, illustrations of control and power conversion units, and of components and control stations, as well as tables of sizes and dimensions. Cutler-Hammer, Inc.



This Bailey boiler control system assures maximum fuel economy in the operation of two 50,000 lb per hour capacity pulverized coal-fired boilers at Toms River.

How Bailey helps control STEAM COSTS AT TOMS RIVER

With a Bailey-engineered control system you can count on a high output of available energy per unit of fuel, whether you operate a small industrial boiler or a large central station boiler.

They did at Toms River — Cincinnati Chemical Corporation's plant in Toms River, N. J.! Bailey Controls help them save fuel by continuously maintaining desired operating conditions.

Most high-efficiency steam generating plants rely on Bailey because:

1. A Complete Line of Equipment

Bailey manufactures a complete line of standard, compatible pneumatic and electric metering and control equipment that has proved itself. Thousands of successful installations involving problems in measurement, combustion and automatic control are your assurance of the best possible system.

2. Experience

Bailey Engineers have been making steam plants work more efficiently for more than forty years. Veteran engineer and young engineer alike, the men who represent Bailey, are storehouses of knowledge on measurement and control. They are up-to-the-minute on the latest developments that can be applied to your problem.

3. Sales and Service Convenient to You

There's a Bailey District Office or Resident Engineer close to you. Check your phone book for expert engineering counsel on your steam plant control problems.

A139-1

Instruments and controls for power and process

BAILEY METER COMPANY

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In Canada—Bailey Meter Company Limited, Montreal

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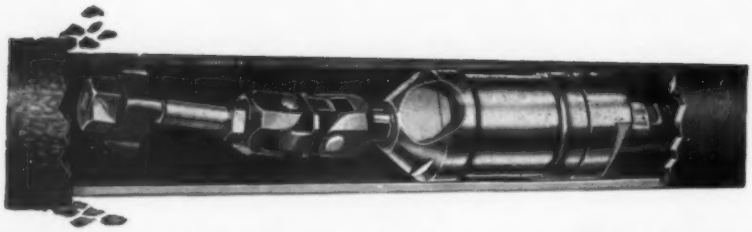


ROTOJET®

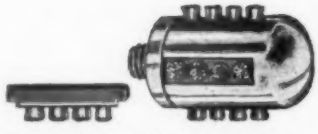
Cleans Fire Tubes ▸▸▸▸▸▸ FAST ▸▸▸▸▸▸ INSIDE and OUTSIDE

You can now clean fire tubes inside as well as outside faster with a new Rotojet. The new Rotojet is the most powerful tube cleaner we ever built. It won't stall at low speeds caused by heavy loads. Roto expanding heads and brushes thoroughly clean soot scale inside tubes. A Roto vibrating head (illustrated above) knocks off water scale adhering on the outside.

Try the new Rotojet, and no other tube cleaner will ever satisfy you.

Economical Roto Brushes

Roto expanding brushes and heads have separately replaceable wearing elements. These inexpensive parts save time, money, and critical materials. Send for details.



Roto expanding brush, showing a replaceable brush element. Brings down tube cleaning cost. Maintains high cleaning efficiency.

Roto solid wire brush.

Model S525 ROTOJET Air-driven Motor with swing-frame head for 3" O.D. tubes.

Model S505 ROTOJET Air-driven Motor with 2-arm head for 2" O.D. tubes.

ELLIOTT COMPANY – ROTO PLANT

Tube Cleaner Specialists Since 1910

147 Sussex Avenue, Newark, N. J.

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151 Improved Clutches — Electroclutches, compact, electrically operated devices for engaging and disengaging machinery gears and drives, are described in 20-pp Catalog 6304-1A. Gives examples of applications, provides data and specifications and summarizes general application information. This clutch is available in six basic designs with torque capacities from 1.8 through 13,000 lb-ft. I-T-E Circuit Breaker Co.

152 Flexible Gear Couplings — Twenty-pp Catalog C-5 is a reference manual on flexible gear couplings. Details range of standard types and sizes, provides information on available special types. Sections of booklet are devoted to cost-cutting advantages, installation information, typical applications, lubrication requirements, and engineering data. The Sier-Bath Gear and Pump Co., Inc.

OTHER EQUIPMENT

153 Steam Turbine — Design and construction features of steam turbine-generating units rated 2000 through 16,500 kw are covered in 40-pp Bulletin 03B7654A. Cross-section diagrams of each of four basic type units designed for condensing, non-condensing, condensing automatic extraction, and non-condensing automatic extraction operation, are included. Color diagrams trace hydraulic control and lubrication system. Allis-Chalmers Mfg. Co.

154 Mechanical Draft Fans — Catalog 1321 describes efficiency and quietness of airfoil blading for full range applications in three product lines: combustion air forced and induced draft; primary air for pulverized fuel injection; and high-pressure air supply for cyclone furnace boilers. Illustrated with photos, catalog includes general engineering data on each product line. Sturtevant Div., Westinghouse Electric Corp.

155 Insulation Board — Asbestolux, a lightweight, fireproof insulation board, is described in this 12-pp brochure. Presents illustrations of dozens of existing installations in a variety of buildings. A description of installation procedures is accompanied by detailed scale drawings. Diagrams show fire protection afforded in some typical applications. North American Asbestos Corp.

156 Metallic Sealing Rings — Eight-pp Form 895 covers performance and use of metallic sealing rings. Illustrates and defines four major types of sealing rings, and discusses combinations of materials used by this manufacturer. Drawings show typical applications. Offered with bulletin is a 4-pp specification table on most widely used sealing rings. Metal Products Div., Koppers Co., Inc.

157 Dust Collector Installation — This 8-pp bulletin describes a recently installed dust collection system for collecting nearly 5 tons of dust per hour. Including illustrations, booklet covers both first and second stage collectors which comprise 48 cyclones and two giant twin-section electric precipitators. Buell Engineering Co., Inc.

158 Steel Equipment — Many types of steel shelving, drawers, lockers, work benches and tables and other storage and shop equipment are presented in 48-pp Reference Manual 185. Fully illustrated, catalog provides information on features

HERE'S A
SPECIAL ADVANTAGE
OF THE
LJUNGSTROM:®

high availability

These five basic factors assure you that the Ljungstrom Air Preheater will give exceptionally long periods of uninterrupted availability:

1. **UNIFORMLY HIGHER COLD-END METAL TEMPERATURES.** This minimizes the danger of local corrosion due to cold spots.

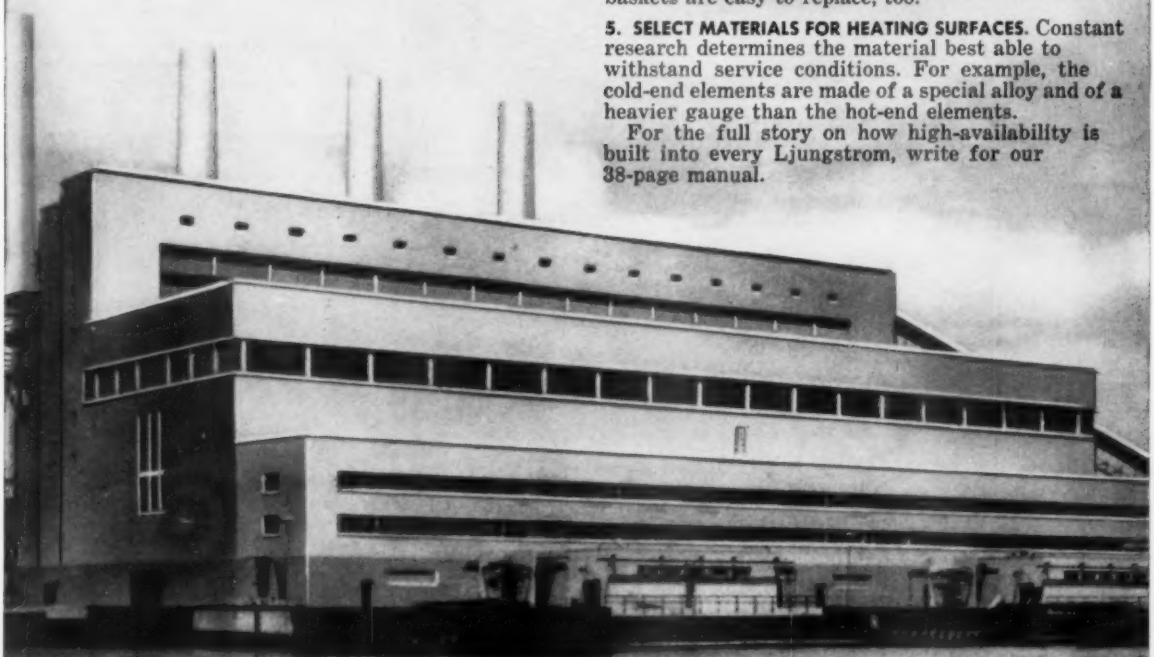
2. **POSITIVE CLEANING ACTION.** A mass-flow soot blower is normally installed at the cold end of the Ljungstrom where deposits are most apt to accumulate. Daily cleaning with superheated steam or compressed air removes any deposits.

3. **INSPECTION PORTS.** You can see for yourself, at any time, the condition of the heating surfaces.

4. **REVERSIBLE COLD-END BASKETS.** Elements in the cold end are separated into small baskets, which can be inverted when one end starts to wear thin. These baskets are easy to replace, too.

5. **SELECT MATERIALS FOR HEATING SURFACES.** Constant research determines the material best able to withstand service conditions. For example, the cold-end elements are made of a special alloy and of a heavier gauge than the hot-end elements.

For the full story on how high-availability is built into every Ljungstrom, write for our 38-page manual.



The Air Preheater Corporation 60 EAST 42nd STREET, NEW YORK 17, N. Y.

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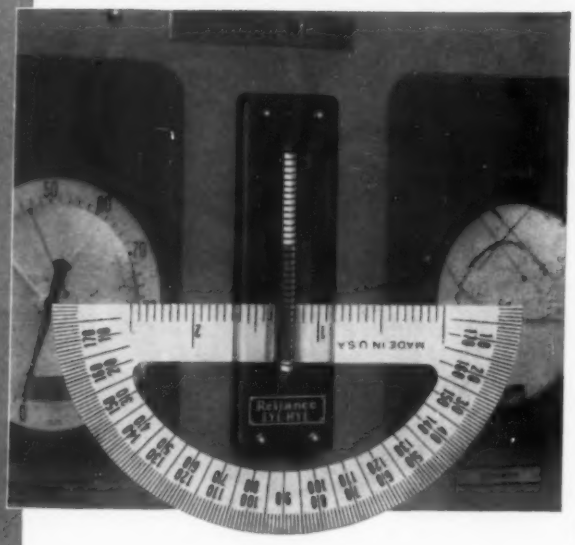
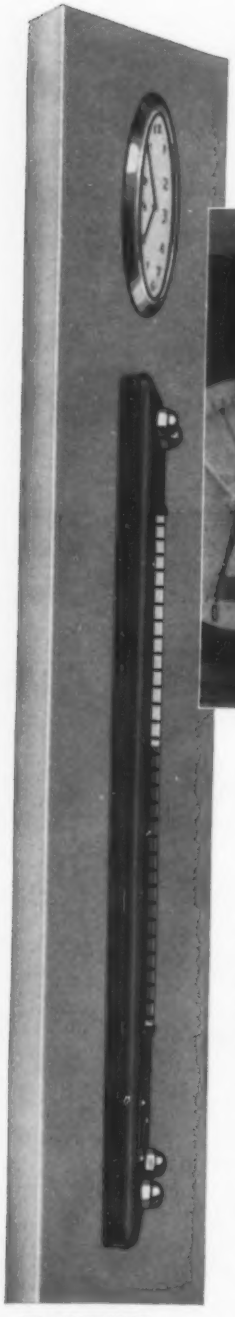
New Reliance EYE-HYE

gives you 180° reading of boiler water levels





The EYE-HYE can be equipped to actuate additional signals — lights or horns — to warn operators if dangerously low or high levels occur.

Bright green-white image *clearly visible* all around your control room

Wherever you stand in front of your panel — even 90° from center, either side — you can read the picture in EYE-HYE's new protruding window. The brightly illuminated green indicating fluid that spells "water" contrasts sharply with the upper white (steam) section. A new lighting principle brings extra carrying power to the image.

There's no change in the dependable manometric gage principle of operation. EYE-HYE still retains its original simplicity, successful for over 20 years. Thousands of operators prefer the familiar liquid column indication, as in conventional water gages . . . Models are available for any working pressure up to 2500 psi. Write for catalog information — mention your pressure.

The Reliance Gauge Column Co.

5902 Carnegie Ave. • Cleveland 3, Ohio

For more data circle 519 on Post Card

and applications and includes dimensional data. Also included is price list. Equipto.

159 Bent Tube Boilers — Bulletin VF-VS2, 22 pp, describes a line of bent tube boilers designed to serve a wide variety of industries with diverse steam generating requirements. Principal data and schematic diagrams of typical installations included. Henry Vogt Machine Co.

160 Tubular Products — Testing and inspection methods used during manufacture of company's line of seamless and welded carbon, alloy and stainless steel tubular products are described in 24-pp Bulletin TB-420. Explains how these techniques are integrated into the manufacturing process. Tubular Products Div., The Babcock & Wilcox Co.

161 Instantaneous Water Heaters — Eight-pp Bulletin IW-34 features information on indirect type instantaneous water heaters, their application, selection and installation. Method of estimating hot water demand is detailed and example problems included. Typical instantaneous heater installations are diagrammed, and selection tables given. Bell & Gossett Co.

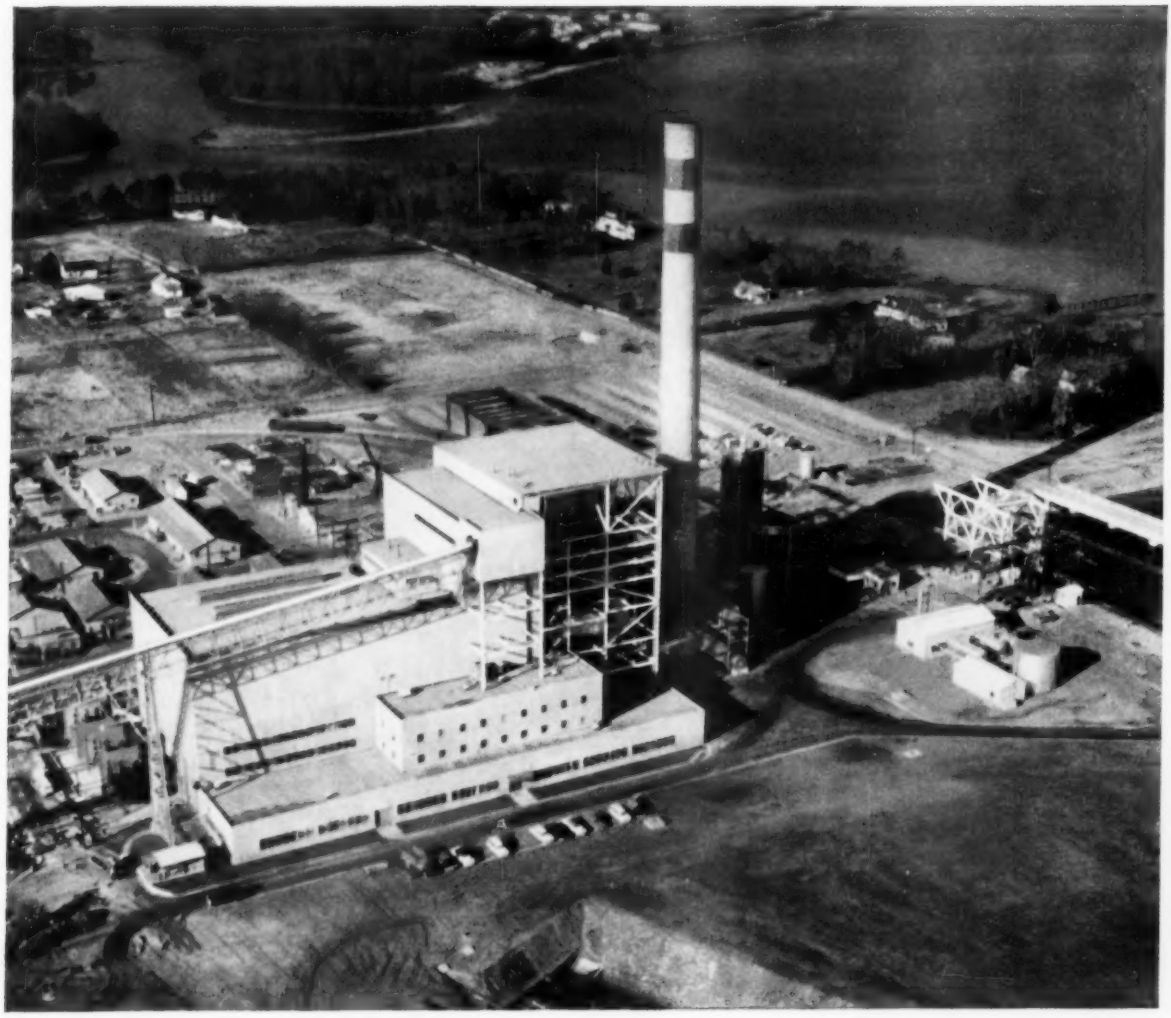
162 Rust Prevention — This illustrated bulletin describes company's rust eradicator for removing rust, scale and congestion from water systems, as well as the service offered by the company for assuring protection from the damaging effects of water. Photos of typical applications are included. The North American Mogul Products Co.

. . . *Outstanding Among This Month's Catalogs*

163 Wire Rope Use, Care — An information piece for any plant engineer concerned with wire rope, this 36-pp handbook gives up-to-date pointers on the use and care of wire rope. Tells how to select right rope for specific needs, and covers methods of socketing, splicing and installation, and safety factors. Typical causes of wire rope failure are given, and chapters are devoted to lubrication, inspection and measuring. Wire Rope Corp. of America.

164 Special Fire Protection — Devoted to special hazard fire protection, this 44-pp booklet covers both equipment and methods. Tells how to recognize special fire-hazardous conditions in a plant. Discusses in detail the major types of fire protection, telling how each functions, giving advantages and limitations, and illustrating some areas in which it is successfully used. Features of interest include a definition of fire-protection terminology and a quick selector chart showing suitability of common extinguishing agents with some 40 fire hazards. Grinnell Co., Inc.

165 Rubber Products —Comprehensive information on industrial rubber products used by manufacturing, petroleum, agricultural, processing and other industries is presented in this 72-pp catalog. It describes and illustrates various types of hose, conveyor belting, packing, plastic pipe, garden hose and couplings. Information on applications, product construction and lengths available is included, along with specifications. Acme Rubber Mfg. Co.



Pioneering power from an uncommon fuel

Producing power profitably on a large-scale, commercial basis from delayed refinery coke has been accomplished for the first time on the East Coast at the new Yorktown Station of the Virginia Electric & Power Company.

This pioneering steam power plant burns delayed coke, which is economically available from the neighboring refinery of American Oil Company, supplemented by bituminous coal and refinery gas. Today, out of its initial 150,000 kw capacity, the Yorktown Station fulfills the refinery's electric power needs . . . and brings significant operational savings to both the utility and the oil company.

Stone & Webster Engineering Corporation was associated with this power station project from its inception — through the negotiations between the utility and the refinery and the design and construction — to its commercial operation, and is presently engaged on the installation of the second 150,000 kw unit.

Stone & Webster's skill and experience is available to you anywhere in the world . . . for a single phase or for full responsibility for the completion of your project.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

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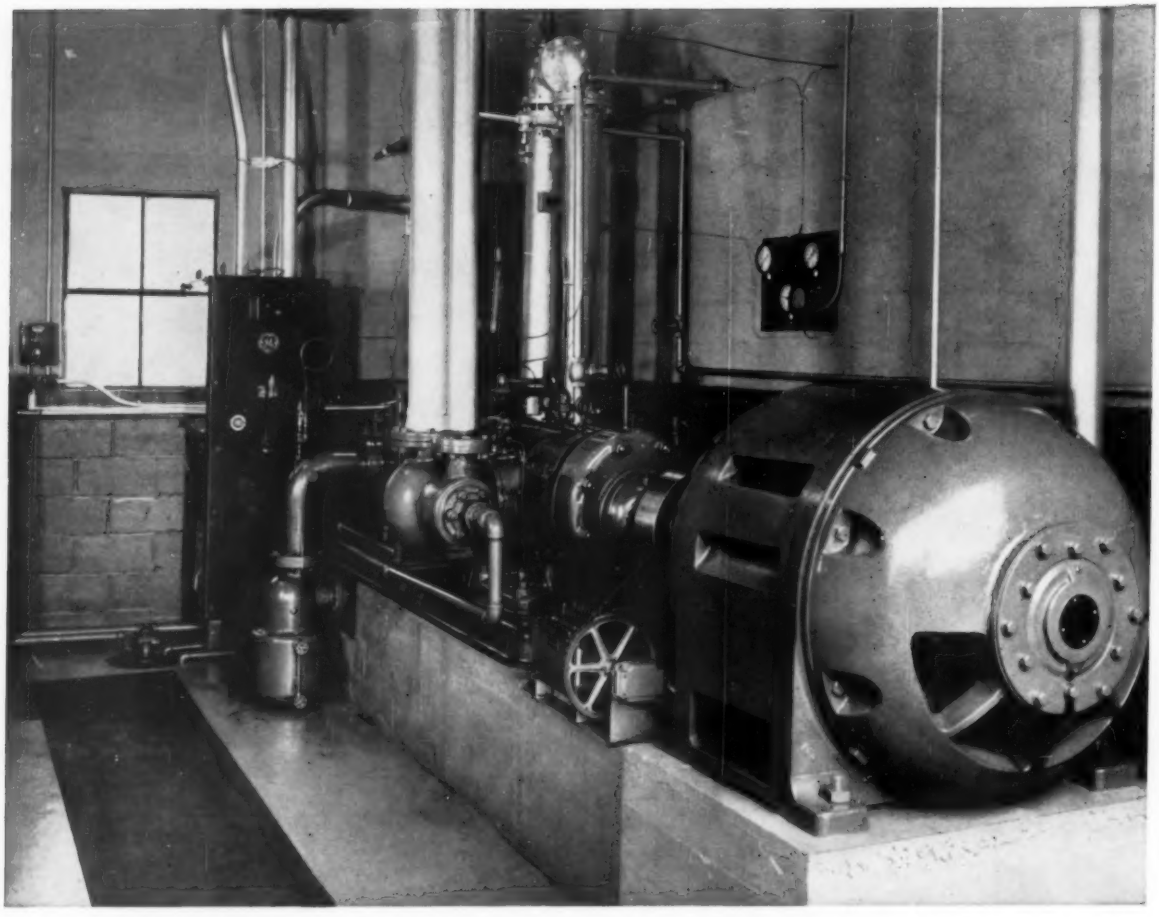

Fuller Rotary Two-Stage Compressor, C135-135H. Capacity 680 c.f.m., 100-lb. pressure, 690 r.p.m., 150 hp. motor.

16,000 HOURS OF OPERATION WITH NO MAINTENANCE

Empire Steel Castings, Inc., Reading, Pennsylvania, installed a C-135-135H Fuller Rotary Two-stage Compressor in April 1953. After 32 months—approximately 16,000 hours of operation—the compressor received a routine inspection, when a new set of blades was installed in the higher-pressure cylinder.

The Empire engineers report no downtime since replacement, although they've added 4,000 operating hours. Prior to switching to Fuller, their former experience with compressors was a different story—as many as several overhaulings in one year. With Fuller equipment furnishing a constant high capacity air supply, production costs have been greatly reduced.

Here's how Empire uses compressed air:

- In the molding department, supplying all air for pneumatic rammers, all squeeze and jolt machines, automatic set-out and lifting apparatus of mold conveyors, automatic shake-out machines, mold cleaning and spraying equipment.
- In the core department, for ramming equipment, spraying and torch drying equipment, core oven operation as well as core blowing equipment.
- In the cleaning department, pneumatic chipping hammers and grinders, blacksmith requirements, sand-blasting, pressure testing and miscellaneous tools.
- In the heat-treating department, heat treating furnace operation and cooling equipment.

To get all the facts and engineering data, write today for Bulletin C-5A.

C-298
3662

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SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION
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Fuller

PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

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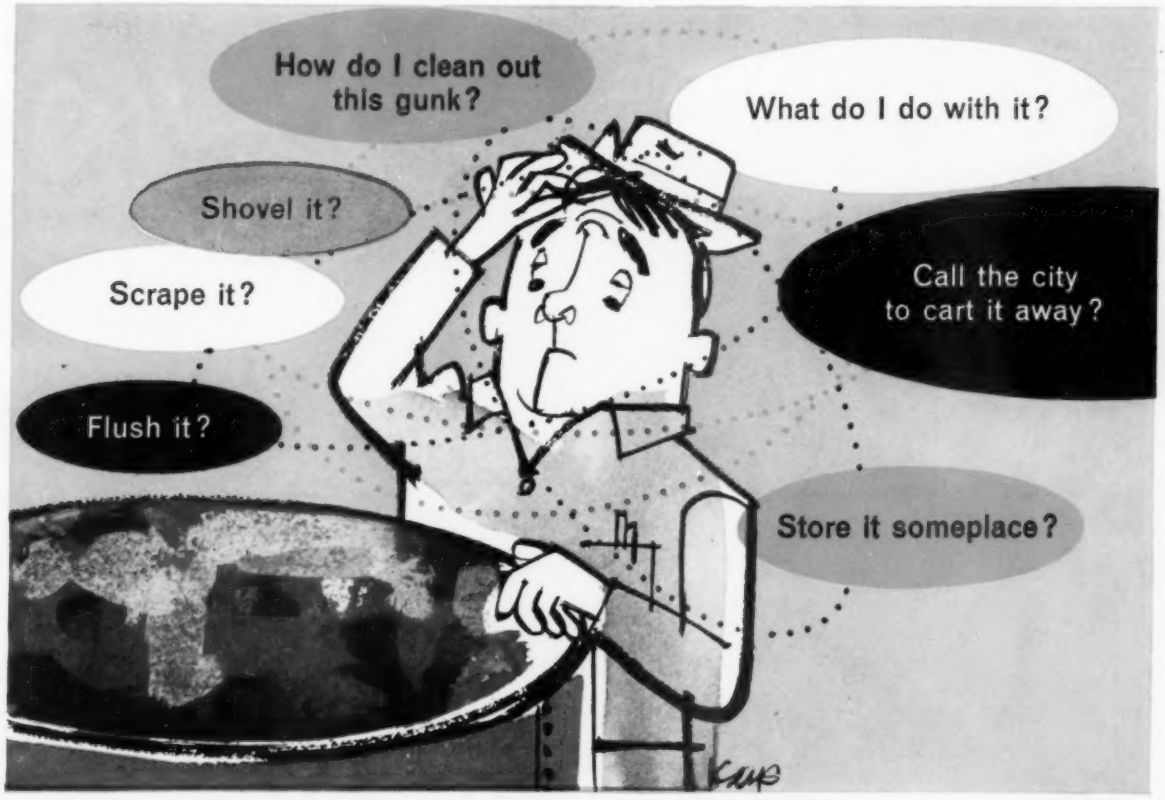


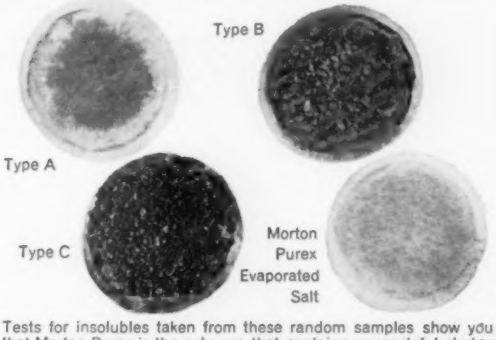
Brine tanks never need cleaning out when you use sludge-free Purex Salt

Yes, we mean never! You prevent costly shutdowns for maintenance. You save time and completely eliminate labor costs for cleaning out brine tanks. For Morton Purex Salt is 100% soluble. It will leave no accumulation of sludge—shale and sulphates—in either your brine or water-softening system.

What's more, none of your purchase price or freight bill for Purex goes toward paying for insolubles. This is an important saving, for in every 100 lbs. of ordinary salt you buy, you assume the risk of paying for up to 5 lbs. of shale and sulphates. In a 50-ton carload of ordinary salt, you may pay for as much as 5,000 lbs. of sludge. And you buy salt with "built-in" maintenance problems.

With sludge-free Morton Purex Salt, you get high-purity evaporated salt made in a controlled-particle size to prevent packing and channeling. Purex can be used in bulk wet storage systems and in the Morton Model E Brinemaker.

These filter pads (approximately 1/6 actual size) show you how much insoluble matter (sludge) you get in just 5 lbs. of various types of salt



Tests for insolubles taken from these random samples show you that Morton Purex is the only one that contains no wasteful sludge or insolubles.

For more information about Morton Purex Salt and for free, expert help on any water-softening or brine-making problem, write or wire:

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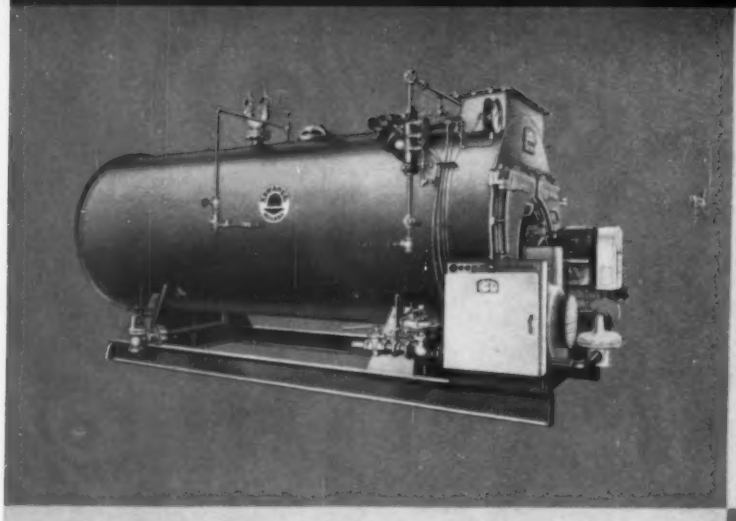
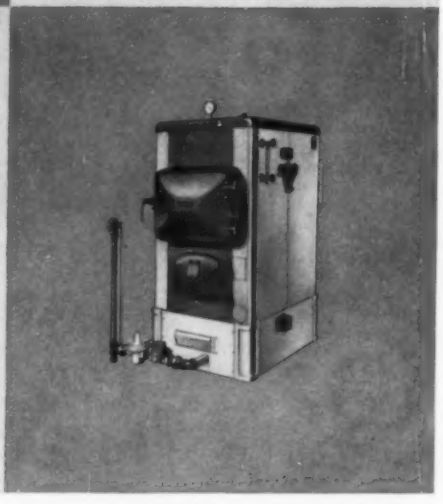
KEWANEE® PACKAGES

36 sizes span a full range of fuels





Now Kewanee's family of integrated boiler-burner packages covers a spread of sizes from 18 to 651 hp in high pressure models . . . 216,000 to 21,855,000 Btuh, low pressure. The fuel range is all-inclusive, too—oil from No. 1 through No. 6 . . . natural, manufactured, mixed or LP gas . . . oil-gas combination firing on any Scotch type package . . . forced draft eliminates high stacks. Factory assembling and fire-testing on Scotch type packages, when desired, means only five simple connections for installation. For complete facts on any type, any size or any fuel, contact your nearby Kewanee Man. AMERICAN-STANDARD, KEWANEE BOILER DIVISION, 113 Franklin Street, Kewanee, Illinois.

AMERICAN-Standard

KEWANEE BOILER DIVISION

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CONDENSER TUBE CLINIC

Edited by **ARTHUR W. TRACY**, Metallurgical Engineer,
The American Brass Company, Waterbury, Connecticut

Stresses and their Effects can be Minimized

STRESS-CORROSION CRACKING—The stress-corrosion cracking of copper alloys requires the simultaneous action of moisture, air, ammonia, and stress. Stresses may be residual or applied. All Anaconda condenser tubes are processed so as to minimize residual tensile stresses which may be formed during fabrication. Applied stresses from installing tubes in heat exchangers, nonuniform thermal expansion in tube bundles, or misalignment of condensers with other equipment occasionally cause stress-corrosion cracking.

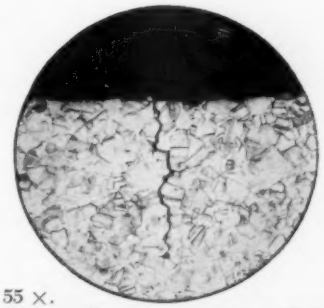
Admiralty metal and aluminum brass tubes, although known to be susceptible to stress-corrosion cracking, seldom crack in condensers. Although ammonia is often present, either by chance or design, in vapors entering condensers, the amount of air (oxygen) is usually so small that the corrosive action of the ammonia is limited. It is obvious that noncondensable gases should be vented from condensers, not only to increase thermal efficiency, but to minimize corrosion.

ANACONDA Arsenical Admiralty-439 and ANACONDA Ambraloy-927 condenser tubes seldom stress-corrosion crack in normal service. Where operating conditions are severe enough to cause stress-corrosion cracking of these alloys, ANACONDA Cupro Nickel, 10%-755 and ANACONDA Cupro Nickel, 30%-702 tubes are recommended.

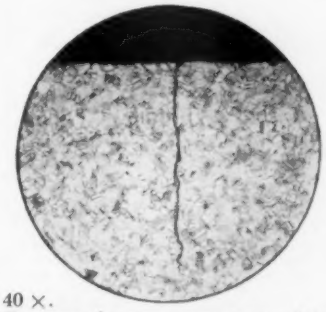
STRESS-RELIEF ANNEALING – Inasmuch as copper-alloy condenser tubes may stress-corrosion crack from stresses caused by cold-forming operations such as U-bending, the stresses should be removed by relief annealing the cold-formed portion of the tube.

FATIGUE CRACKING – Vibrations from moving parts of equipment or from pressure pulsations can induce stresses in condenser tubes high enough to exceed the endurance limit and cause a fatigue-crack failure. Vibration of a tube may even disturb water flow enough to cause impingement pitting at the point of greatest amplitude of vibration and the resulting pits can act as stress raisers. Pulsations can often be dampened by placing baffles or grids in the path of high-velocity vapors. Vibration of tubes can also be dampened by placing wooden slats between rows of tubes. Cupro Nickel, 30%-702 Tubes are more resistant to fatigue cracking than admiralty and aluminum brass.

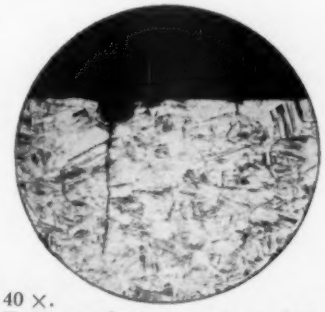
TECHNICAL ASSISTANCE—Your tube problem may need special consideration. We are always ready to advise in the selection of the right alloy to give the best service. Write for the new edition of Publication B-2. The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 8878



55 ×.
Intergranular stress-corrosion crack in 70/30 brass tube from oil refinery heat exchanger. Longitudinal section.



40 ×.
Transgranular stress-corrosion crack in admiralty metal tube from oil refinery heat exchanger. Longitudinal section.



40 ×.
Fatigue crack starting at pit in aluminum brass tube from power plant condenser. Longitudinal section.

ANACONDA® **Tubes and Plates for Condensers and Heat Exchangers**

NOMINAL COMPOSITIONS OF SOME ANACONDA CONDENSER TUBE ALLOYS

	Arsenical Admiralty-439	Ambraloy-927 (Aluminum Brass)	Cupro Nickel, 10%-755	Cupro Nickel, 30%-702
Copper, %	71	77	88.35	68.90
Nickel, %	..	..	10	30
Zinc, %	27.96	20.96	..	..
Aluminum, %	..	2	..	..
Tin, %	1	..	..	..
Arsenic, %	0.04	0.04	..	..
Manganese, %	..	..	0.40	0.60
Iron, %	..	..	1.25	0.50

For more data circle 524 on Post Card

How to beat the high cost of temperature control

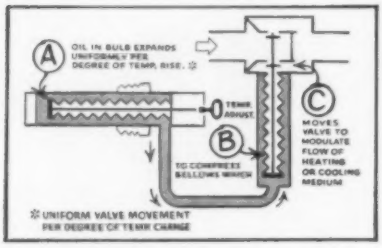
The practical approach to temperature control

By John W. Ritter, Test Engineer, SARCO Company, Inc.

Precise temperature regulation is essential in many processing operations, not only for quality control, but for maintenance of output as well.

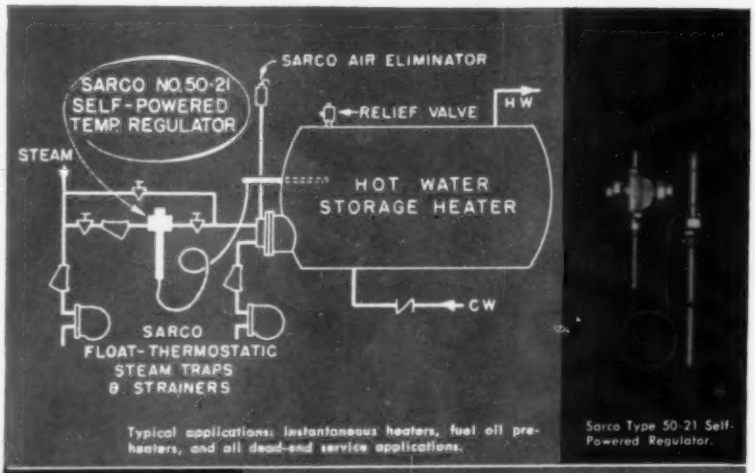
Manual temperature control is unsatisfactory because of the possibility of spoilage and loss of quality control which can result from irregular or indifferent hand regulation.

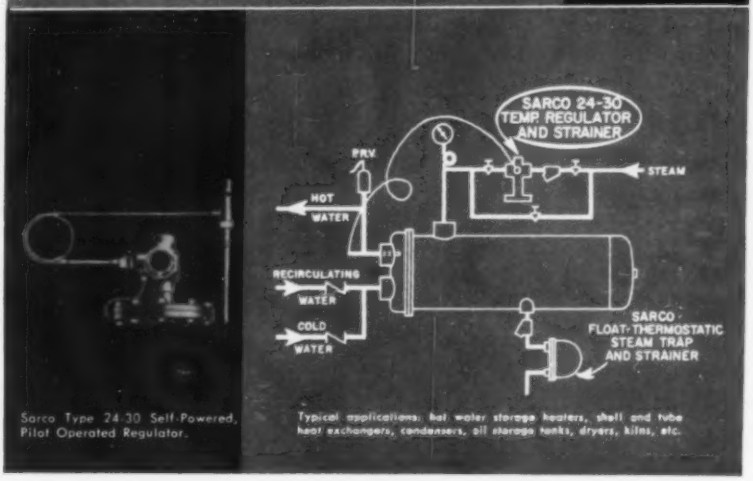
Automatic controls are available in a wide variety, including pneumatic, electronic, and self-powered. Pneumatic and electronic controls are relatively expensive to purchase and install, and may require frequent maintenance. However, in most applications, control requirements can be achieved very successfully by the use of relatively simple, economical Sarco Self-powered Regulators.


A
OIL IN BULB EXPANDS UNIFORMLY PER DEGREE OF TEMP. RISE. ✲
TEMP. ADJUST
B
C
MOVES VALVE TO MODULATE FLOW OF HEATING OR COOLING MEDIUM
TO COMPRESS BELLOWS WHICH
✲ UNIFORM VALVE MOVEMENT PER DEGREE OF TEMP. CHANGE

This drawing shows simplicity of operation of the Sarco 50-21 Temperature Regulator, which consists of a thermostat, capillary tubing, and a valve.

Sarco controls, like the 50-21 and the 24-30, have the required degree of sensitivity and dependability, combined with the ruggedness inherent in the sealed capillary tube construction. Because these Sarco controls do not depend on external power, such as electricity or compressed air, they have established long records of sustained, reliable operation. They are an economical and practical solution to the problem of maintaining continuous watchdog duty over processing temperatures.


SARCO AIR ELIMINATOR
SARCO NO. 50-21 SELF-POWERED TEMP. REGULATOR
RELIEF VALVE
HW
STEAM
HOT WATER STORAGE HEATER
CW
SARCO FLOAT-THERMOSTATIC STEAM TRAPS & STRAINERS
Typical applications: instantaneous heaters, fuel oil preheaters, and all dead-end service applications.
Sarco Type 50-21 Self-Powered Regulator.


SARCO 24-30 TEMP. REGULATOR AND STRAINER
PRV
STEAM
HOT WATER
RECIRCULATING WATER
COLD WATER
SARCO FLOAT-THERMOSTATIC STEAM TRAP AND STRAINER
Sarco Type 24-30 Self-Powered, Pilot Operated Regulator.
Typical applications: hot water storage heaters, shell and tube heat exchangers, condensers, oil storage tanks, dryers, kilns, etc.

Self-powered automatic temperature regulators by SARCO . . .

have these 5 marked advantages: No compressed air or electrical wiring required. No delicate mechanisms to adjust or maintain. No packing glands to stick or require maintenance. No shutdown during power failure. No specialized maintenance required.

Sarco Self-Powered Controls are self-contained and can be installed by any pipe fitter. They are so reasonable in cost that you can afford Sarco automatic heating controls for every application in your plant. Write for 10-page Sarco Control Bulletin No. 620.

6346-B

SARCO
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635 Madison Ave., New York 22, N. Y.

STEAM TRAPS • TEMPERATURE CONTROLLERS • STRAINERS • HEATING SPECIALTIES

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NEEDS DEPENDABLE
NOURISHMENT too!
Take a tip from your family's dependence on "nature's most nearly perfect food". Coal is nature's most nearly perfect fuel. It's here in abundance for ages to come, a dependably low-cost and most efficient source of "go power"! It's convenient too —right on Industry's doorstep.
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BITUMINOUS COALS FOR EVERY PURPOSE
Ask our man! BALTIMORE & OHIO RAILROAD, BALTIMORE 1, MD., Phone: LExington 9-0400

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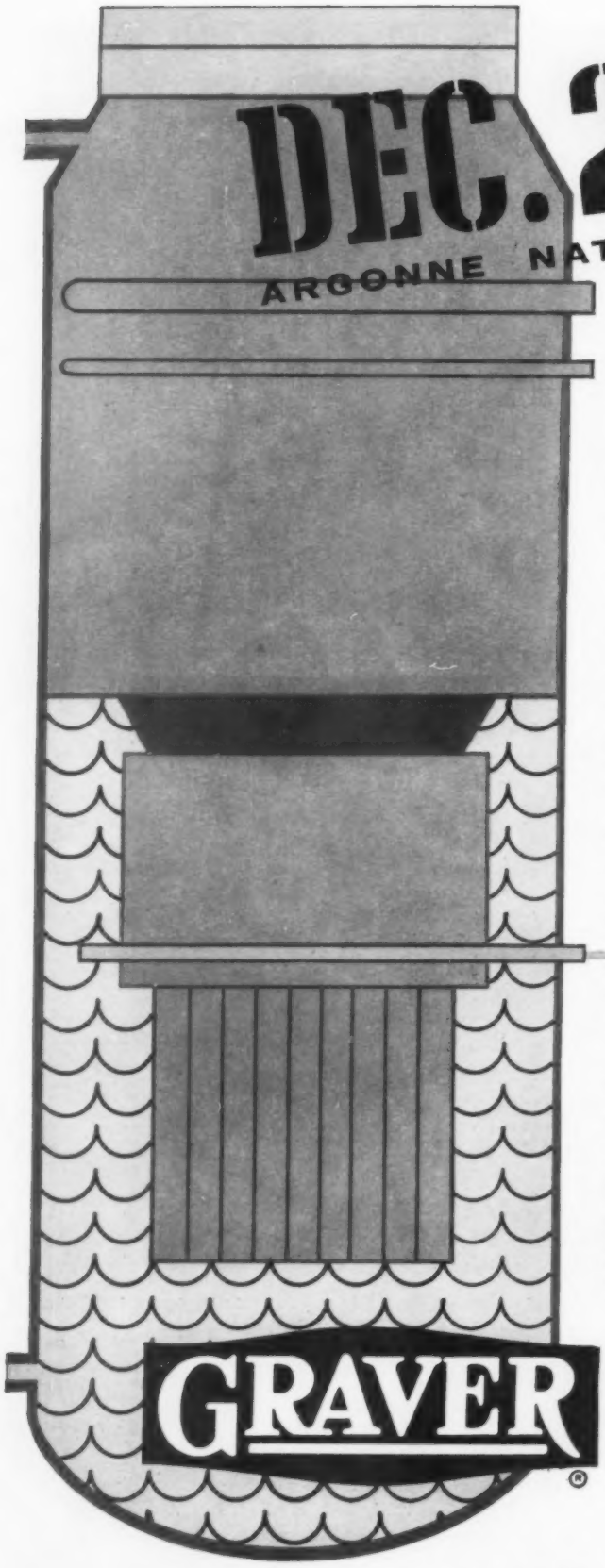

DEC. 29, 1956

A date long to be remembered as a milestone in our expanding nuclear technology. On this day, after many months of scientific investigation, planning and construction, the Experimental Boiling Water Reactor reached full power generation.

This reactor, dedicated to the peace and prosperity of mankind, employs a promising new system for the generation of power from nuclear fuels. Operating on a direct steam cycle, it eliminates the need for intermediate heat exchangers and permits operation of the reactor at a pressure no higher than that required for the turbine generator system.

The primary advantage of this "direct-boiling" reactor is the simplicity of the reactor itself and associated power system. In the simplest terms, the reactor is operating as a boiler. Nuclear energy liberated by a chain reaction heats the uranium metal fuel plates, which, in turn, transfer the heat to the water around them. This is diagrammatically shown in the sketch at left. Part of the steam produced, at the proper pressure, is used for the generation of electricity.

The continuous removal of corrosion products from the water in the reactor vessel is the function of the reactor purification system. This all-stainless steel system removes water from the bottom of the reactor and, after cooling, delivers it to the ion exchange columns. The resin exchange beds remove all ionic impurities. Purified water is then pumped back with the feedwater. This ion exchange system consists of two Graver rubber-lined, mixed-bed units, 20" dia. x 84" high, having four inches of lead shielding and weighing about 18,000 pounds each.

Graver also furnished a second separate ion exchange, or demineralizing, system for the treatment of makeup water. That system has two rubber-lined, mixed-bed units, 24" dia. x 9'0" high, and a complete regeneration arrangement.

Although only a small part of an important project, both of these systems had to meet the extremely high requirements of engineering, construction and performance required in all Atomic Energy work — another example of Graver's high engineering standards for water treatment equipment.

Industrial Department: I-311-A

GRAVER WATER CONDITIONING CO.

Division of Union Tank Car Company

216 West 14th Street, New York 11, N. Y.

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ATOMICS

A section of POWER ENGINEERING covering current and forthcoming developements in the field of Nuclear Power throughout the world

ANDREW W. KRAMER
Editor

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What Goes Into a Nuclear Plant? 41

Ultra-Pure Water—Prime Requisite for Nuclear Plants By W. A. Homer 42
This article discusses the great difference between the feedwater requirements of a nuclear power plant as compared with those of conventional power plants. Whereas the impurities in the boiler water of a coal or oil fired plant are measured in parts per million, in a nuclear power plant such impurities cannot exceed more than a few parts per *billion*. The author discusses the reasons for these extreme purity requirements and describes the systems that have been developed to provide and maintain water of this degree of purity.

Shippingport Completes Five Month's Operation 44
When Shippingport Station was dedicated on May 26, the event marked the completion of the first five-month period of operation of this pressurized water nuclear power station. As indicated in this article, this station is important because it is the first large power station to go into operation in the United States. The features of PWR have been described in detail many times so this article is concerned largely with the costs of this station, which are unusually high because of the pioneer nature of the project.

List of Suppliers of Principal Equipment for Shippingport 46

WHAT GOES INTO A NUCLEAR PLANT

THE HISTORY OF atomic energy development to date can be divided, roughly, into three five-year periods, beginning in 1942. The period from 1942 to 1947 was strictly the period of military development; the years when the Manhattan project flourished and all efforts were directed towards the production of nuclear weapons.

This was followed by the five-year period which witnessed the gradual awakening regarding the possibilities of nuclear power for commercial use—the period from 1947 to 1952. At this time nearly all essential information concerning reactor technology was still highly secret, but the basic principles had been known ever since the publication of the Smyth Report and there was a growing feeling among certain leaders in the power industry that more intensive action should be taken to demonstrate the technical and economic feasibility of nuclear power.

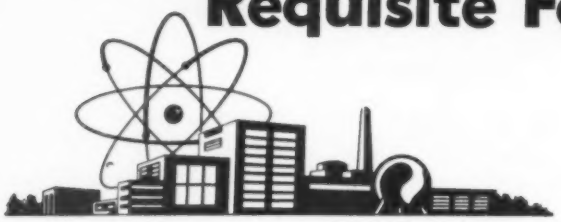
As a result of the increased interest and the growing demand for information, the next five-year period, from 1952 to 1957, saw the emergence into the open of a vast amount of secret data on reactor technology, and with it the rapid development of many new reactor concepts. The AEC instituted its Power Demonstration Reactor Program, and a number of power reactor projects were completed, among them the Shippingport Station, reported on in this issue of ATOMICS.

Thus, in a brief 15 years, modern technology has brought nuclear power from a vague concept to a practical technical reality. Much remains to be accomplished but the groundwork has been laid and the years ahead will see much more intensive development in all aspects of the field, particularly in the reduction of costs and simplification of design.

While a vast amount of information on the design and construction of nuclear power plants has appeared in the technical literature during the past ten years, there are still many who regard a nuclear power plant as being something quite strange and mysterious and very different from conventional power plants. As far as the reactor is concerned this is quite true; a reactor is quite a different sort of gadget from anything in a conventional power plant. This does not hold for the rest of the nuclear plant, however; that is made up of the same, more or less standard, valves, fittings, piping, instruments, controls, structures, wiring, etc, that conventional plants are made of. It is largely to show the great variety of conventional equipment that goes into a nuclear plant that the list of suppliers of equipment for Shippingport is presented in this issue. Despite the fact that this list covers only the major equipment, it represents a fairly large cross-section of American industry.

Andrew W. Kramer

Ultra-Pure Water—Prime Requisite For Nuclear Plants



By W. A. HOMER
Grover Water Conditioning Co

ULTRA-PURE water is water that has impurities measured in *parts per billion* (ppb) instead of the usual parts per million. Until a few years ago such pure water could be produced only in the laboratory. Today, ultra-pure water is an absolute necessity for most nuclear reactor power cycles and methods have been developed for producing it in large quantities.

In the treatment of make-up water for conventional power plants, some or all of the following impurities are reduced or removed entirely: turbidity, iron, total dissolved solids, silica, total hardness, alkalinity, oxygen, and carbon dioxide. Impurities and products of corrosion picked up within the cycle which are *not treated* but are carried to the boiler and removed by blowdown, include copper, nickle, chromium, and molybdenum. For high pressure conventional power cycles with steam drums, boiler water concentrations must be limited to a range of 200–500 ppm in the drum.

In nuclear power cycles the requirements are much more stringent. In these cycles, all of the impurities mentioned plus soluble and insoluble radioactive materials (called crud) must be continuously removed from the cycle and the impurity level must not exceed 50–200 ppb. An additional requirement is the reduction of fluorides and chlorides to not more than 10 ppb each.

Reasons for Extreme Purity

1. *Efficient Heat Transfer.* The highest temperature used in nuclear water cycles today is about 630 F, due to the temperature limitations of fuel elements. Nuclear plants, therefore, operate at a low temperature differential, and under such conditions efficient heat transfer requires clean surfaces which can be maintained only by the use of ultra-pure water.

2. *Radioactivity.* Due to neutron bombardment, solids passing through a nuclear reactor become radioactive. If water with perhaps 500 ppm total impurities were used, most of the impurities would become radioactive and would pass from the nuclear reactor area to other parts of the system. Thus, no part of such systems would be safe for operation or maintenance. This danger decreases in proportion to the decrease in impurities.

3. *Corrosion.* Corrosive products which attack metals become even more corrosive in the presence of radiation. Sulfides, chlorides and fluorides can become potent acids under radiation.

4. *Materials of construction.* The most corrosion-resistant metals are not used in nuclear reactor cycles because they are too expensive. Therefore stainless steel of the 304 ELC (Extra Low Carbon) type, with its excellent corrosion-resistant qualities, is the metal most widely used. Corrosion is particularly harmful in nuclear plants because the stainless steel surfaces are very thin so as to provide good heat transfer.

5. *Fuel Element Fracture.* Another reason for using ultra-pure water in nuclear systems is to reduce the possibility of fuel element failure through corrosion or scale deposits. Failure of a fuel element would release highly radioactive fission products throughout the water system and this would require lengthy and expensive decontamination procedures. Under such conditions it would be necessary to shut down the plant and all the water in the system would have to be treated and discarded to waste.

Use of Scavenger Demineralizers

There are various types of nuclear power cycles and all operate in different ways. Some cycles use water in all the loops while others use water in only certain loops. However, the method of purification which is common to all water loops is internal self-purification of condensate by filter-demineralizer scavengers.

Internal self-purification of condensate reduces impurity levels to parts per *billion* by purifying any portion of the condensate up to 100 per cent. It accomplishes this by *polishing* within the cycle an already purified feedwater such as the effluent from a conventional multi-bed demineralizer system or the condenser hotwell. Figure 1 shows a typical arrangement of this type of treatment system as used in a conventional though supercritical once-through design where water purity requirements are similar to those for nuclear cycles.

Figure 2 is a simplified flow-diagram of the Experimental Boiling Water Reactor at Argonne National Laboratory, showing the location of

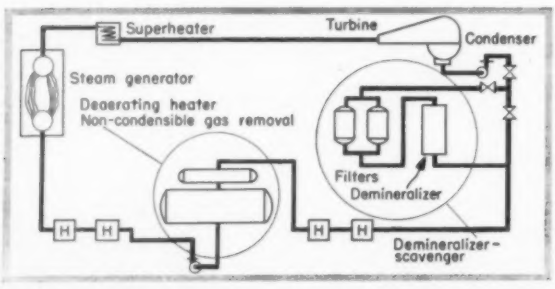


Fig. 1. Flow diagram of internal self-purification scavenging system designed by Graver Water Conditioning Co

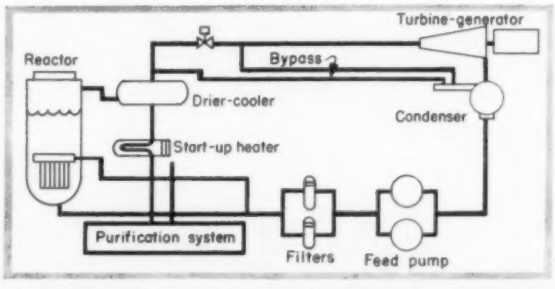


Fig. 2. Simplified diagram of EBWR system showing position of scavenging system and other water treating equipment

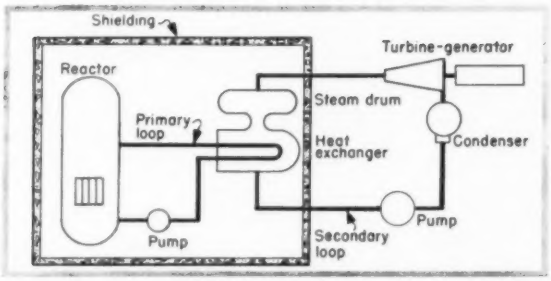


Fig. 3. Simplified flow diagram of pressurized water system

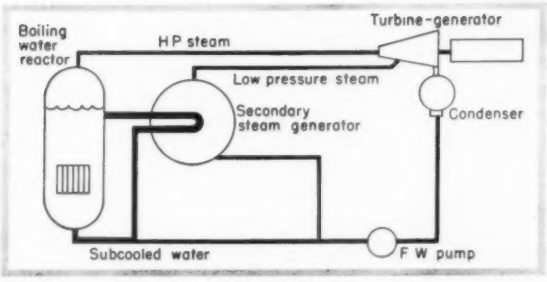


Fig. 4. Diagram of dual-cycle boiling water reactor system

the scavenging system. The internal scavenging system consists of a mixed-bed or multi-bed demineralizer with filters on both sides to filter the condensate before it enters and after it leaves the demineralizer. The demineralizer is generally of the standard type, but resins, internal construction, and flow rates are designed for use with the scavenging system. The filters are generally of the cellulose element or leaf type. Chemicals used for regeneration (when regeneration units are used) are sulfuric acid and caustic.

Nuclear Reactor Cycles

A brief discussion of the various nuclear cycles will show where in the cycle ultra-pure water must be used and how the scavenging system fulfills the water requirements.

Pressurized Water Reactor. As shown in Fig. 3, the pressurized water cycle has two loops. The primary or hot cycle has pressurized water circulating through the reactor and heat exchanger in a closed loop. The water in this loop will pick up trace amounts of metal such as iron, manganese, chromium and copper. These trace amounts of metal would tend to build up in both soluble and particle form, and must be removed from the system by internal scavenging. This is accomplished by cooling a portion of the water circulating in the hot loop by passing it through regenerative heat exchangers and then through scavenging demineralizers, after which it is returned to the system. Since the particles being removed are generally radioactive, the demineralizers are of the non-regenerative type. Exhaust resin is removed to radioactive waste disposal facilities.

The secondary loop in the pressurized system is essentially isolated from the radioactive or primary loop by heat exchangers. One might think that this secondary cycle could be compared to that of moderate pressure boilers and that water treatment requirements would be the same. This is not the case since, as indicated earlier, steam generating equipment is designed for extremely high rates of heat transfer. Therefore, the water in the secondary loop must also be maintained at a very high purity level to prevent accumulation of deposits on the heat transfer surfaces. Since the water in this loop is not radioactive, a regenerative scavenger demineralizer is used. The water is maintained at about the same degree of purity as in the primary loop.

Dual Cycle Boiling Reactor. In the dual-cycle boiling reactor (Fig. 4) a portion of the water in the reactor is circulated through a heat exchanger or flash tank and then returned to the reactor. Steam generated in the heat exchanger by heat transfer or by flashing is delivered to an intermediate stage of the turbine. This secondary steam is at a lower pressure than the steam produced in the reactor. The two loops are not isolated and impurities picked up anywhere in the cycle may end up in the hot loop. For this reason present designs of dual-cycle systems include equipment for demineralizing all of the condensate returning to the reactor. The scavenger demineralizers are designed to operate at very high flow rates of from 25–50 gpm per sq ft, and the resins are regenerated in separate tanks. The flushing of resins into separate tanks, an innovation developed especially for this system, is shown in Fig. 6.

Liquid Metal-Cooled Reactors. In liquid metal-cooled reactors heat is removed from the reactor core by liquid sodium, or by an alloy of sodium and potassium (Nak). Usually there are three loops; two loops containing sodium and one containing water. The first sodium loop, which is radioactive, transfers heat to the second sodium loop which in turn transfers heat to the third loop containing water. This last loop generates steam. Ultra-pure water is required in the water loop as in the

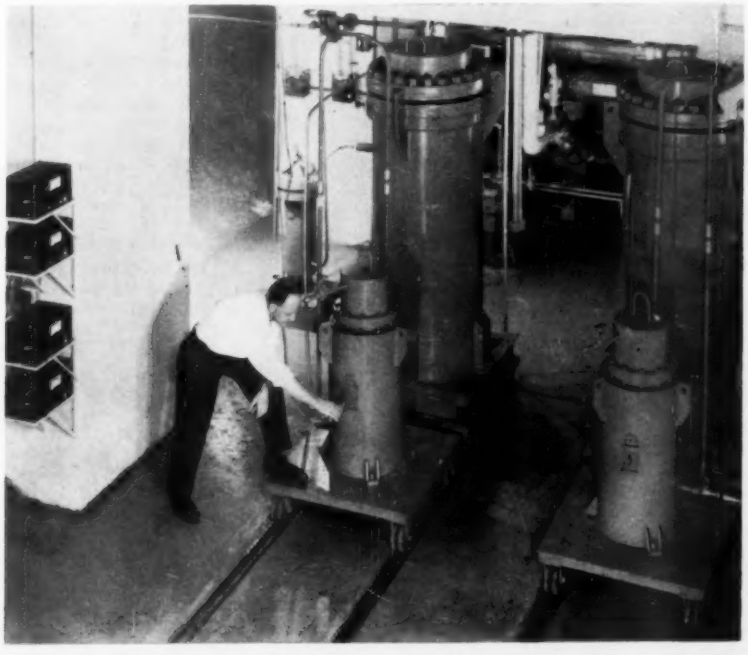


Fig. 5. Graver filters and demineralizers used in Argonne water purification

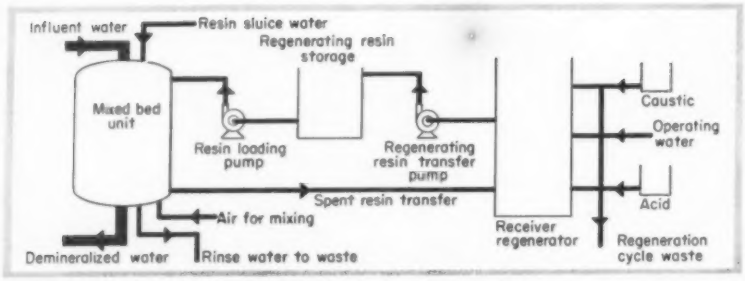


Fig. 6. Flow diagram of externally regenerated mixed-bed ion exchange unit designed by Graver Water Conditioning Co

other reactors because solids must be kept low to prevent deposition on the interior surfaces of the steam and water system. A small portion of the condensate is passed through scavenger demineralizers to maintain water purity.

Homogeneous Reactors. The homogeneous reactor uses uranyl sulfate in a solution of very pure water. The solution is both fuel and coolant since it is circulated through the core where heat generation takes place and then out to a heat exchanger where the heat is transferred to a conventional water cycle. Of course, it is impossible to demineralize the solution in the first loop because the fuel which it carries would be removed in the process. It is quite obvious that very pure water is required for the initial fuel solution as well as for the primary cycle make-up water. The secondary loop has the same requirements with regard to water purity as discussed for other cycles.

Conclusion

General conclusions concerning this consideration of water treatment for nuclear power cycles may thus be summarized as follows: 1. Ultra-pure water measurable in parts per billion is required. 2. Internal self-purification of condensate by scavenger demineralizers is used to maintain purity in water loops. 3. Primary loop water containing solutions or slurries rather than pure water are never passed through scavenging systems. 4. When hot loops come in direct contact with water loops, all the condensate in the latter must be purified. In all other cases only a portion of the condensate requires purification. 5. Radioactive loop water is demineralized by non-regenerative units and the resins discarded to waste. In other systems the demineralizers can be regenerated because the resins do not generally become radioactive.

Although this discussion presupposes the use of H_2O, the principles involved in the treatment of D_2O, in reactor systems where the latter is used, apply equally well, though some modifications of the demineralizers might be required.

Shippingport Completes Five Months' Operation

WHEN THE Shippingport Atomic Power Plant was dedicated on May 26, the event marked the completion of the first five-month period of operation of this plant. The plant first produced electric power on December 18, 1957, and a short time later, on December 23, it operated successfully at its full design capacity of 68,000 kw. Of this total, 8000 kw (11.7 per cent) are required for the auxiliary load, giving the station a net generating capability of 60,000 kw. The total net electrical output of the plant as of May 14 was 32,050,000 kwh.

The construction of Shippingport has attracted wide attention because it is the first full-scale central station nuclear plant to go into operation in the United States. Although this plant produces energy for use in the Duquesne Light Co system, its primary purpose is to advance the technology of pressurized water reactors rather than to generate electricity for commercial use. The plant will not be operated to furnish continuous power with a maximum load factor.

ATOMICS

Shippingport Station was built under the AEC Power Reactor Development Program by the Atomic Energy Commission. The over-all costs for the project, total $121,400,000. Of this amount, $98,400,000 represents Government funds, $22,500,000 the contribution of the Duquesne Light Co, and $500,000 that of the Westinghouse Electric Corp. The pressurized water reactor project was carried out under the supervision of Rear Admiral Hyman G. Rickover, Chief of the Naval Reactors Branch of the AEC. Westinghouse Electric Corp designed, developed, and built the reactor portion of the plant. The Duquesne Light Co built the electrical generating facilities and will own them.

Under the terms of the agreement with the AEC, Duquesne furnished the plant site and the turbine-generator plant which it operates and maintains at no cost to the government. Duquesne also operates and maintains the nuclear portion of the plant, assuming all labor costs for up to 100 persons. In addition, the company furnished services, materials, equipment and facilities with a net value not to exceed $5,000,000, for the design, development, and construction of the nuclear portion of the plant. The contract runs for five years. During a five-year period, which began December 18, 1957, Duquesne will purchase steam from the Government at a rate of 8 mills per kwh of net electricity.

By subcontract to Westinghouse, the Stone & Webster Engineering Corp provided the architect-engineer services for the nuclear portion of the plant. The Dravo Corp also under subcontract to Westinghouse, installed the nuclear plant. Burns & Roe, Inc acted as agent-constructor for Duquesne in building the turbine-generator portion of the plant.

Specified Requirements

The principal plant features specified to Westinghouse in designing the pressurized water reactor were: 1. A net electrical output of 60,000 kw at 600-psi steam pressure. 2. Reactor to be cooled by H_2O at 2000 psi. 3. First core to last for 3000 hr at full power operation. 4. Refueling with minimum shutdown period. 5. Reactor control to be as simple as possible. 6. Commercial equipment to be used wherever possible. 7. Cost of operation to be minimum consistent with these requirements.

Costs

It is interesting to take the total cost of the Shippingport project, namely, $121,400,000 and divide it by 60,000, the net electrical capacity.

The result is $2023 per kw. It is very obvious from this figure that Shippingport can by no stretch of the imagination be considered competitive with a conventional power plant, since the latter can be built for an average cost of around $150 to $175 per kw. As indicated previously, however, it was not the intention that this station be competitive either in capital costs or cost of operation. While it is expected that the plant will ultimately operate at a net power level much greater than the 60,000 kw, the operating cost will still be very high compared to conventional power costs. The Shippingport turbine-generator has a maximum capability rating of 100,000 kw.

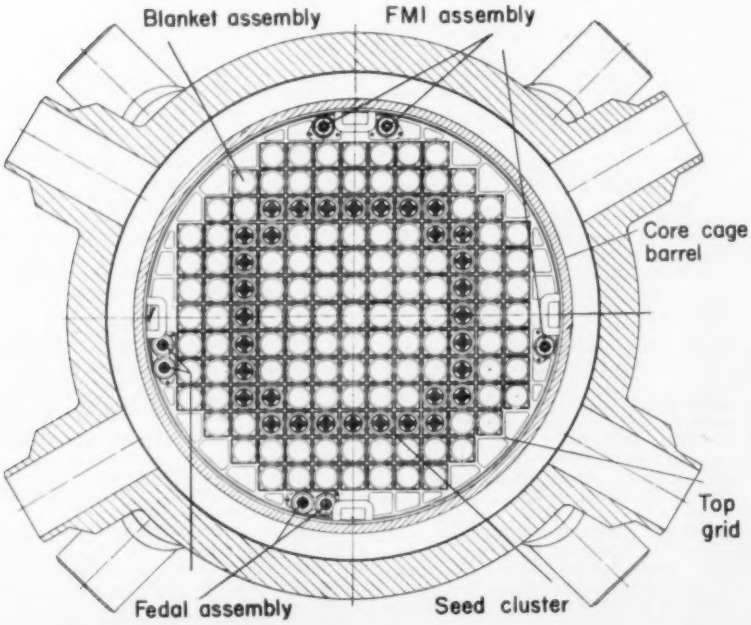
Table I gives a detailed breakdown of all construction costs, and the estimated power costs are summarized in Table II. These estimated power costs are based on operation at 100 per cent load 80 per cent of the time. The life of the core will require two *seeds*, the first producing 3000 full power hours; the second 5000 full power hours, for a total of 8000 full power hours. Power production of the core is 50 per cent from the seed and 50 per cent from the blanket.

To understand what is meant by the terms *seed* and *blanket* it will be helpful to refer to the diagram of the cross-section of the Shippingport core. Of the total 145 fuel assemblies in the core, 32 are the highly enriched seed assemblies which are arranged in a hollow square with blanket assemblies both inside and outside the seed. In this arrangement a core is produced which utilizes neutrons leaking from the highly enriched seed elements to cause fission of nuclei in the blanket. The seed fuel contains approximately 165 lb of U^{235}. The natural uranium blanket fuel contains 0.7 per cent of U^{235}. The U^{235} in the blanket (approx 198 lb) is dispersed throughout the U^{238}, and cannot by itself sustain a chain reaction. Moreover, the hollow square arrangement of seed assemblies, even in the presence of water, cannot sustain a chain reaction without the help of neutrons reflected from at least a portion of the blanket.

During operation, some of the neutron output of the fissionable U^{235} is absorbed in the U^{238}, producing plutonium-239 which is also fissionable by thermal neutrons. Plutonium fission is added to that of U^{235} as a source of energy. Since the quantity of plutonium builds up during the life of the core, the blanket material will produce an increasing proportion of the over-all power by *burning* the plutonium in place. The life of the seed is estimated to be at least 3000 hr at full power. The blanket material should last more than one seed life.

Table I. Summary of PWR costs

I. Construction, Nuclear Plant		
(a) Government Funds	$49,500,000	
(b) Duquesne Light Contribution	5,000,000	
(c) Westinghouse Electric Corp. Contribution	500,000	
	$55,000,000	$ 55,000,000
II. Construction, Turbine-Generator Plant		
(a) Duquesne Light Funds	$17,500,000	$ 17,500,000
Total Construction		$ 72,500,000
III. Research and Development		
(a) Government Funds	$48,900,000	$ 48,900,000
Total Construction and Research and Development		$121,400,000



Cross section of Shippingport reactor core showing blanket and seed clusters

The AEC selected the pressurized water reactor for the Shippingport plant because at that time it was the only concept with proved feasibility for power production. Previously, the prototype pressurized water reactor for the submarine Nautilus had been built. In designing the plant, a multiple loop concept with spare capacity was used to obtain high reliability. The use of a single primary coolant loop to handle the entire reactor heat output would have required pipes, boilers, pumps, and valves many times the size of any previously fabricated. The four-loop design permitted reduction of the main loop piping to approximately maximum size that manufacturers were equipped to make. The pumps were designed to be about four times larger than any of the type previously built; this was considered a reasonable extrapolation. Finally, the plant was designed to develop its desired power output by using three of the four steam generating loops, with the fourth loop as a spare.

In calculating the power cost given in Table II, it will be noted that the cost of fuel per kwh is given as 43.4 mills. This is based on a total fuel cost of $20,845,000. Considering full load (60,000 kw) operation for the full life of the core (8000 hr), the total net electrical power produced from the fuel is $60{,}000 \times 8000 = 480 \times 10^6$ kwh. Dividing the total fuel cost by this figure, gives: $20{,}845{,}000 \div 480 \times 10^6 = 43.5$ mills per kwh.

The blanket contains 14.6 tons of natural UO_2. At a price of $40.50 per kg this comes to a total of $537,000. The seed consists of 182 kg of highly enriched uranium. At a price of $16,000 per kg, this gives a total of 42,912,000, to which must be added a processing loss of $364,000. Thus the total cost of a seed is $3,276,000.

The AEC use charge (4 per cent per year) is as follows:

Blanket — 2½ yr = 10%	$54,000
Seeds — 2 years each = 85	262,000
Total	316,000

Thus the cost of the fissionable material is:

Blanket	$ 537,000
Seeds	3,276,000
AEC Use Charge	316,000
Total	$4,129,000

Fabrication and non-fissionable material cost is $14,816,000, and the fuel inventory carrying charge is $1,895,000. Thus the total cost of fuel is arrived at as follows:

Fissionable materials	$4,129,000
Fabrication and non-fissionable materials cost	14,816,000
Fuel inventory carrying charge	1,895,000
Total fuel cost	$20,845,000

Nuclear fuel involves financial problems quite different from those of coal or oil. It requires a large initial capital outlay that must be financed, with these financing costs written off against the power produced. Money is required in various amounts during fabrication, use, and reprocessing. This cost is assumed to be equivalent to 10 per cent of the total core cost, including fissionable material.

It will be obvious from the figures given here on capital costs and power costs, that Shippingport is not economically competitive with conventional power plants, and as stated earlier, it was not expected that this station would be competitive. The technical feasibility and reliability of the PWR concept, however, have been established beyond a doubt. The ultimate position of the pressurized water reactors in the nuclear power industry will depend upon the success achieved in reducing costs of power from these systems — success which can come only from operating experience.

Despite the extensive technical background available from other pressurized water projects, the AEC found it necessary to undertake a considerable amount of research and development for Shippingport, which added to the cost. For example, fabrication of the core required the first large-scale production of uranium oxide, zircalloy-clad fuel elements. The pressure vessel, too, is the largest of its kind ever constructed in the United States.

No attempt is made here to describe the details of Shippingport since they have been adequately covered in innumerable articles and papers during the last five years. The significance of this station is that it is the first large nuclear power plant in the United States, and its operation will be regarded with great interest the world over.

Table II. Estimated cost of power

Capital Investment	22.7 mills/kwh
Fuel	43.4
Operations	3.3
Total	69.4
Fuel Credits	5.0
	64.4 use 64 mills/kwh

The following list of suppliers of principal equipment in Shippingport Station discloses an interesting fact and that is that a nuclear power station is made up to a large degree of more or less standard components supplied by the same firms which have supplied equipment for conventional power stations for years. Long as this list is, it is by no means complete; many jobbers, construction firms, and firms doing special fabricating operations have been omitted for lack of space. We present this list primarily to show the number and variety of commercial organizations that had a part in the construction of this first large power station of the coming nuclear era. The list represents a fairly large cross section of American industry.

List of Suppliers of Principal Equipment for Shippingport

AIR REDUCTION SALES—Welding Equipment
ALCO PRODUCTS, INC—Heat Exchangers
ALDRICH PUMP CO—Hydrostatic Test Pump
ALIQUIPPA BLOCK AND SUPPLY—Concrete Building Block
ALLEGHENY LUDLUM STEEL CORP—Heat Exchanger Tubing
ALLEN-BRADLEY CO—Electrical Components
ALLEN GAUGE & TOOL CO—Blanket Tools, Gages
ALLIS-CHALMERS MFG CO—Main Coolant Pumps; M-G Set
ALLOY MFG CO, INC—Demineralizer Vessel; Ion Exchangers
ALOE SCIENTIFIC—Scientific Equipment
ALUMINUM CO of AMERICA—Aluminum Tubing
AMERICAN BRASS CO—Condenser Tubes
AMERICAN BRIDGE CO—Canal Gates, Structural Steel
AMERICAN CAR AND FOUNDRY—Fabricated Reactor Vessel Filter
AMERICAN CHAIN & CABLE CO, INC—Slings and Wire Rope
AMERICAN INSTRUMENT CO, INC—Laboratory Instruments
AMERICAN RADIATOR & STD SANITARY—Plumbing Supplies
AMERICAN STANDARD (Atomic Energy Div)—Valves, Instrumentation
AMERICAN STEEL FOUNDRY—Inconel-X Springs
AMERICAN STEEL & WIRE CO—Fence
AMERICAN WELDING & MFG CO—Control Rod Shrouds and Details
AMPHENOL ELECTRONIC CORP—Electronic Panel Connectors

ANACONDA WIRE & CABLE CO—Electrical Conductors
ANCHOR DRAWING CO—Centerless Ground Inconel-X Bars
ANCHOR PACKING CO—Gasket Material
ANCHOR SANITARY CO—Plumbing Supplies
ANDALE CO—Misc Small Valves and Strainers
ANTON ELECTRONICS LABORATORIES—Air Monitor Units
APOLLA STEEL CO—Core Pit Stand
ARCADIA SYNTHETIC PRODUCTS, Div of Western Felt Works—"O" Rings and Gaskets
ARCH MACHINERY—Industrial Tools and Equipment
ARMCO DRAINAGE PRODUCTS—Corrugated Pipe
ARMCO STEEL—All 17-4 PH Stainless Steel
ASSOCIATED VALVE & ENG CO—Misc Small Valves
ATLAS FENCE CO—Fence
ATWOOD & MORRILL CO—Motor-Operated Stop Valves
AUTOCLAVE ENGINEERING—Misc Small Valves
AUTOMATIC SWITCH CO—Misc Small Valves
BABCOCK & WILCOX CO—Steam Generators, Piping
BAILEY METER CO—Main Instrument Console
BAIRD-ATOMIC, INC—Laboratory Instrumentation
BAKELITE CO—Insulating Material
BAKER & CO, INC—Cadmium Tubing
BALDWIN - LIMA - HAMILTON CORP — Motor Cranes
BARTH CORP—Machining of Locking Collars
BARTON INSTRUMENT CO—D/P Cells, Flow Switches
BATTELLE MEMORIAL INSTITUTE—Uranium Alloy Fuel Materials
JOHN BEAN DIV OF FOOD MACHINERY & CHEM CORP—Charging Pumps
BEARING DISTRIBUTORS, INC—Bearings, Gaskets

A. O. BECKMAN, INC—Gas Analysis Equipment
BECKMAN INSTRUMENT CO—Beta-Gamma Detector Indicator Channel
BENDIX PRODUCTS DIV, Bendix Aviation Corp—Control Rod Drive Mechanisms
BENKART STEEL & SUPPLY CO—Milwaukee Crane Representative
BETHLEHEM STEEL CO—Reactor Vessel Forgings
JAMES G. BIDDLE CO—Instruments
BISHOP AND BABCOCK CO—Flexible Connectors
BLACK, SIVALLS & BRYSON, INC—Spare Parts for Pumps and Valves
BLAW-KNOX CO, Buflovak Equip Div—Air Locks
BLAW-KNOX CO, Power Piping & Sprinkler Div—Waste Disposal Piping System
E. W. BLISS—Large Machining Work
BODER SCIENTIFIC CO—Instruments
BRISTOL CO—Pressure Transmitters and Receivers
BROSKY X-RAY LABORATORY—X-Ray Evaluation
BRUSH ELECTRONICS—Oscillographs
BUILDERS-PROVIDENCE, INC—Venturi Flow Elements Orifices
BURNS & ROE INC—Agent Constructor
BURRELL CORPORATION—Misc Laboratory Equipment
BYRON JACKSON CO—Boiler Feed Pumps
CAMBRIDGE INSTRUMENT CO—PH Cells and Recorder
CAMDEN COPPER—Vent Gas and Exhaust Filters
CAMERADIO CO—Misc Electronic Parts
CANTON DROP FORGE & MFG CO—Furnished Cruciform Extrusions
CARBIDE SPECIALTY COMPANY—Miscellaneous Machined Parts
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G. O. CARLSON, CO—Stainless Steel Plates

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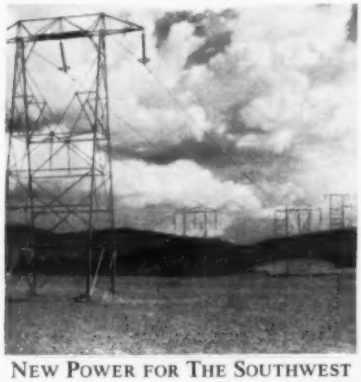
The bulk of this power (6,250,000 kw) is generated by fifteen investor-owned utility companies. Recently these firms made a decision that brings peaceful atomic energy into an important new phase.

Planning together as the Southwest Atomic Energy Associates, they signed a multi-million dollar contract with Atomics International to develop an advanced reactor concept for full-scale atomic-electric power stations. The new project is called AETR (for Advanced Epithermal Thorium Reactor). It promises to be economically competitive with power plants that depend on diminishing, increasingly expensive conventional fuels. Studies will be directed toward the design of a nuclear power plant of 200,000 electrical kilowatts.



NEW POWER FOR THE SOUTHWEST
Fifteen companies pool resources to develop an advanced power reactor

Interest in the project is indicated by a roster of the new group's member companies: Arkansas Power and Light Co., Arkansas-Missouri Power Co., Central Louisiana Electric Co., Inc., Empire District Electric Co. (Mo.), Gulf States Utilities Co., Kansas Gas and Electric Co., Kansas Power and Light Co., Louisiana Power and Light Co., Mississippi Power and Light Co., Missouri Public Service Co., New Orleans Public Service, Inc., Oklahoma Gas and Electric Co., Public Service Co. of Oklahoma, Southwestern Gas and Electric Co. (La.), and Western Light and Telephone Co., Inc. (Mo.).

ing Station in Idaho Falls since last September. It has provided technical and economic information for the construction of OMR power plants now planned for the City of Piqua, Ohio, and large network installations under consideration for this country and abroad. Atomic propulsion systems for supertankers and merchant ships are another important OMR application.

In addition, Atomics International research reactors are helping to bring "Atoms for Peace" to the free world.

SEVEN STATES MAP OUT A PLAN FOR ATOMIC ELECTRICITY

Hardware in Action. AI has built and is now operating two other nuclear power reactors as part of the AEC's program for economical power from atomic energy. One of these is the Sodium Reactor Experiment (SRE) which is supplying nuclear heat to operate an experimental electric power plant installed by the Southern California Edison Co. The SRE is providing technical data and experience for the design of full scale electric stations, such as the 75,000 kw plant for Consumers Public Power District of Nebraska.

AI's Organic Moderated Reactor Experiment (OMRE) has been operating at the AEC's National Reactor Test-

These reactors are now operating in Japan, Germany, Denmark, and the United States. Another is under construction for Italy.

Nuclear Power Abroad. AI works with leading companies overseas. With DEMAG, one of West Germany's largest heavy manufacturers, AI has formed INTERATOM, a jointly owned subsidiary headquartered in Duisburg. AI has a technical assistance agreement with ASEA, a prominent Swedish electrical firm with offices in over 50 countries.

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CHICAGO STEEL TANK—Cooling Water Expansion Tank
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CLEVELAND TOOL & DIE CO—Precision Tools and Fixtures
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COMBUSTION ENGINEERING, INC—PWR Reactor Vessel
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CONELLSVILLE MFG & MINE SUPPLY CO—Base Plate Assembly
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DEMING CO—Centrifugal Fill Pump
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DOW CORNING CORP—Plastics
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DRAVO CORPORATION, Machinery Div—Construction Contractor
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DYNA EMPIRE CORP—Pump Noise Monitor
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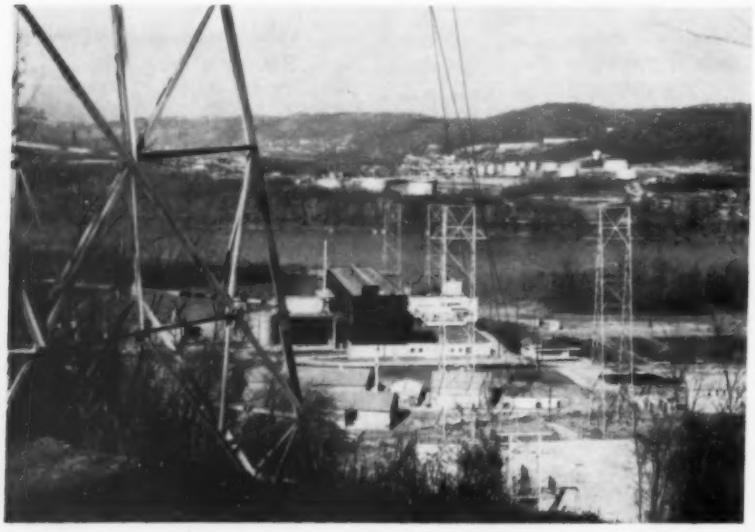
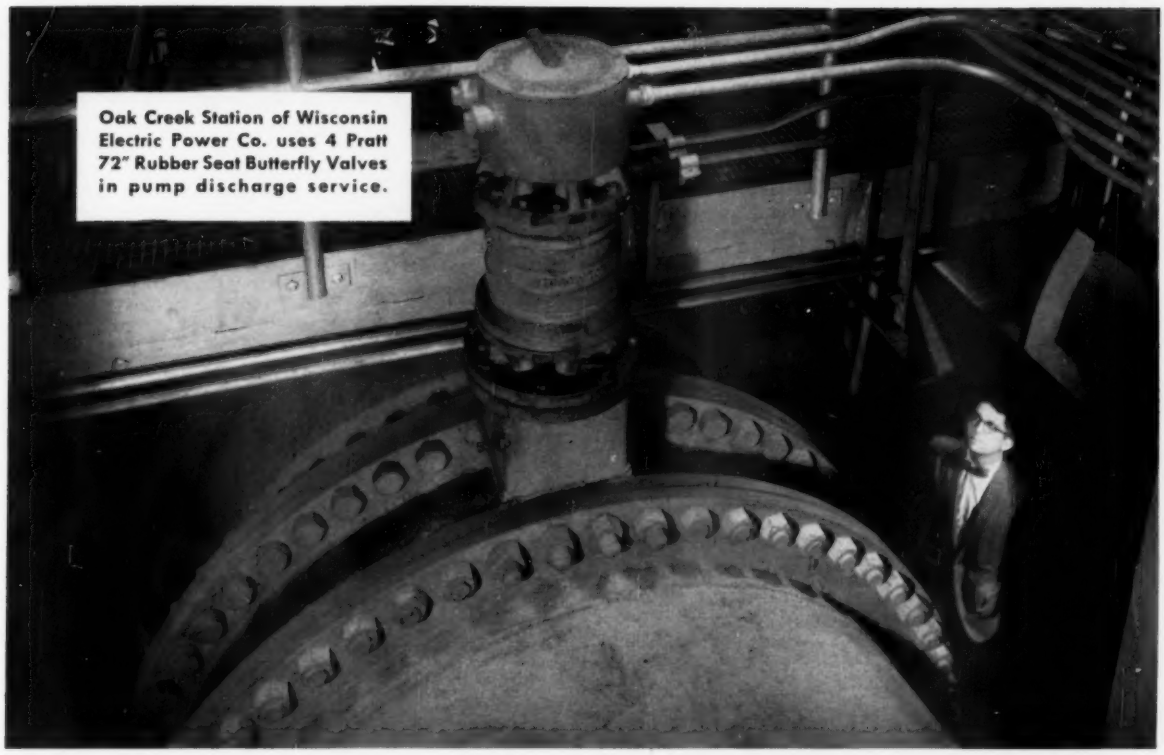


General view of Shippingport Station



Oak Creek Station of Wisconsin Electric Power Co. uses 4 Pratt 72" Rubber Seat Butterfly Valves in pump discharge service.

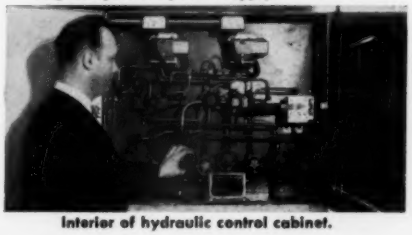
MILWAUKEE...Pratt Butterfly Valves offer "two valves in one" for pump discharge

Pratt Rubber Seat Butterfly Valves in pump discharge service can be made to open and close in synchronization with pump operation, AND they close drop tight—combining, in a single valve, the functions normally achieved by separate shutoff and check valves. The simple combination of disc, shaft and efficient closure provides years of dependable performance without maintenance problems.

Pump discharge valves at Oak Creek Power Plant are hydraulically operated with oil motors. The electro-hydraulic system includes a bank of accumulators and complete auxiliary manual controls to permit operation under any emergency condition.

Pratt pioneered the use of rubber seat butterfly valves in power plants, and today offers the greatest aggregate experience on butterfly valving in the power field. For valve design—**with imagination**—see Henry Pratt.

Felix Kazmerchak, Ass't. Plant Engineer, and Ray F. Egebrecht, Pratt Representative, inspect hydraulic power supply.



Interior of hydraulic control cabinet.

Have you sent for your copy?...of Pratt's 40 page **Manual of Rubber Seat Butterfly Valves.** Useful—contains latest pressure drop and flow data, conversion tables, butterfly valve theory and application. CATALOG B-2.

HENRY PRATT

RUBBER SEAT Butterfly Valves

Henry Pratt Company, 2222 S. Halsted St., Chicago 8, Ill. Representatives in principal cities

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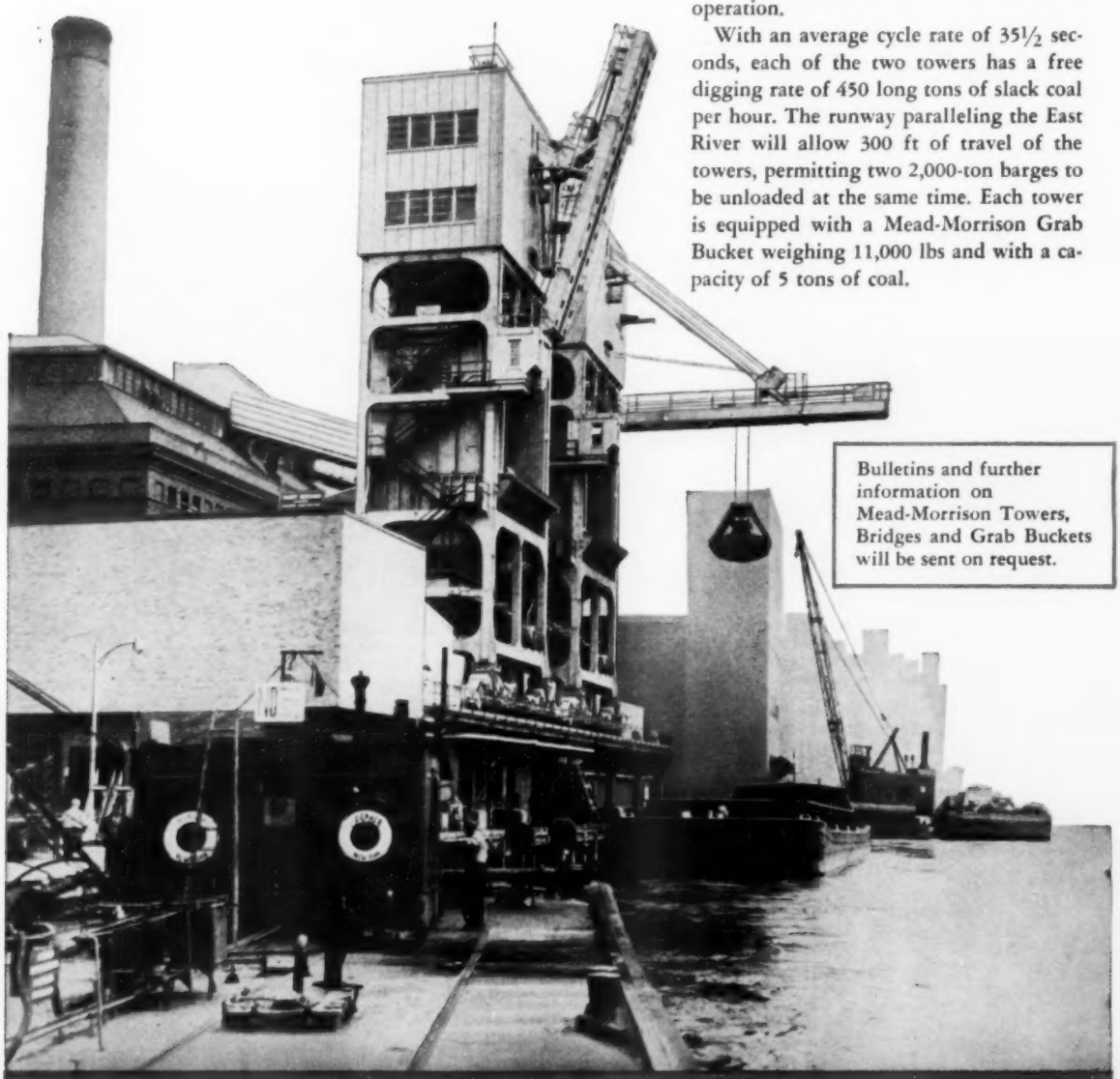
Speedy coal handling

for a New York subway power plant

The power station of the New York Transit Authority at 74th Street and East River has installed two new Mead-Morrison Coal Unloading Towers as part of its extensive modernization program to increase subway power. Because of their prominent position alongside the East River Drive, the towers were specially designed by Mead-Morrison to meet aesthetic standards as well as to include the most modern features for efficient operation.

With an average cycle rate of 35½ seconds, each of the two towers has a free digging rate of 450 long tons of slack coal per hour. The runway paralleling the East River will allow 300 ft of travel of the towers, permitting two 2,000-ton barges to be unloaded at the same time. Each tower is equipped with a Mead-Morrison Grab Bucket weighing 11,000 lbs and with a capacity of 5 tons of coal.



Bulletins and further information on Mead-Morrison Towers, Bridges and Grab Buckets will be sent on request.

MEAD-MORRISON

Division of McKIERNAN-TERRY CORPORATION · Manufacturing Engineers

HARRISON, NEW JERSEY

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A new type of industrial smokestack by Van-Packer

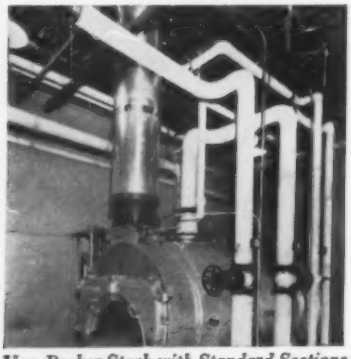
Outlasts steel stacks, costs no more

Won't corrode — The Van-Packer industrial smokestack is made of centrifugally-cast 3-foot refractory sections that will far outlast a steel stack. An aluminum jacket encases each section and eliminates maintenance.

Economical — The Van-Packer costs no more than a steel stack; 2/3rds less than a brick stack. Easy installation, savings on maintenance, and long life results in further savings. Provides high draft equal to that of a comparable brick stack.

For boilers or incinerators — Van-Packer stacks can be installed inside or outside to handle boilers, furnaces or incinerators. Comes in seven diameters from 10-inch ID to 30-inch ID. Handles all fuels.

Available nationwide—Van-Packer Stack is available through local Van-Packer Jobbers and Special Representatives. See "Chimneys — Prefabricated" in Yellow Pages, or write Van-Packer for Bulletin IS-32-59.



Van-Packer Stack with Standard Sections handles boilers and furnaces efficiently. Can be superimposed or floor supported.

Installing this stack is quick and easy. Three-foot sections are simply cemented atop one another with acidproof cement.

Van-Packer Stack with Hi-Temp Sections handles industrial incinerators with continuous flue gas temperatures of 2000° F.

Van-Packer PREFABRICATED REFRACTORY **Stack**

Van-Packer Company • Division of The Flintkote Company
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Sweet's

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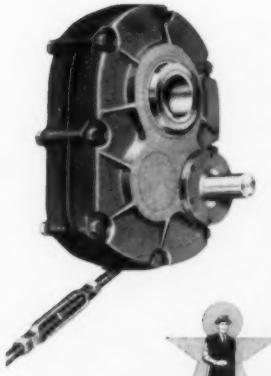
THERE'S QUALITY IN TORQUE-ARM

...AMERICA'S MOST WIDELY USED SHAFT-MOUNTED SPEED REDUCER



Extreme ruggedness and top quality are built into every detail of the Dodge Torque-Arm Speed Reducer—from the specially heat treated helical steel gears to the corrosion resistant semisteel housing. Broad demand has made it necessary to add sizes until today Torque-Arm is America's most complete (and most widely used) line of shaft-mounted speed reducers. Capacities range from 1 to 100 hp; output speeds from 12 to 378 rpm.

Torque-Arm is mounted on the driven shaft, in any vertical or horizontal position. It is anchored by the torque-arm fastened to any fixed object. No need for foundation, flexible coupling, sliding base. No lining up difficulties. The unit is driven through any V-belt drive. Savings up to 1/3 are possible and Torque-Arm's efficiency is high. It delivers 97% efficiency in double reduction models; and almost 99% in single!

Ask you local Dodge Distributor—or write us for bulletin.

DODGE MANUFACTURING CORPORATION
6400 Union Street, Mishawaka, Indiana

CALL THE TRANSMISSIONEER
—your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the white pages of your telephone directory for "Dodge Transmissioneer."

DODGE
of Mishawaka, Ind.

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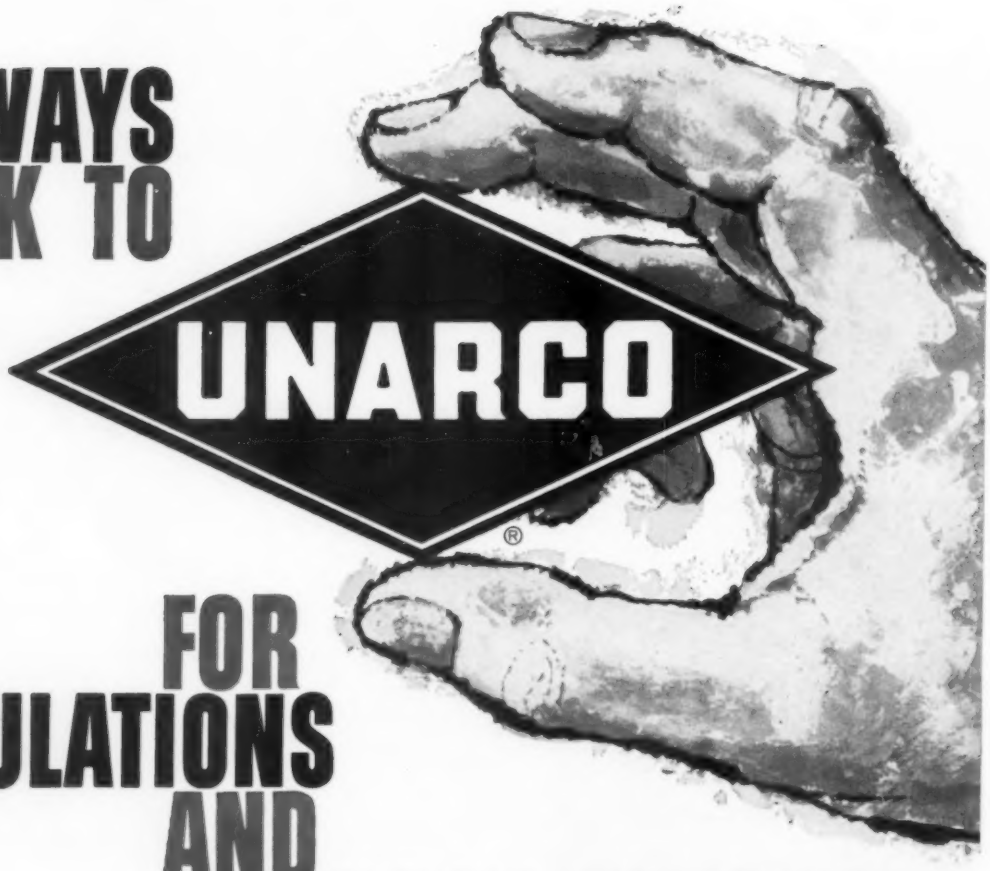

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You know UNARCO, but are you cashing-in on *every* way in which UNARCO can serve you so well? A quick look at the list may point out products you somehow have overlooked, yet all are famous in their fields for progress and performance.

With such broad scope and variety, and because no other source supplies so many different types of pipe insulations, UNARCO skill and experience mean reliable know-how in unbiased recommendations. Over 30 years of specialization is yours when you look to UNARCO!

Please indicate products or service intended when requesting informative literature.

UNION ASBESTOS & RUBBER COMPANY
1111 West Perry Street, Bloomington, Illinois

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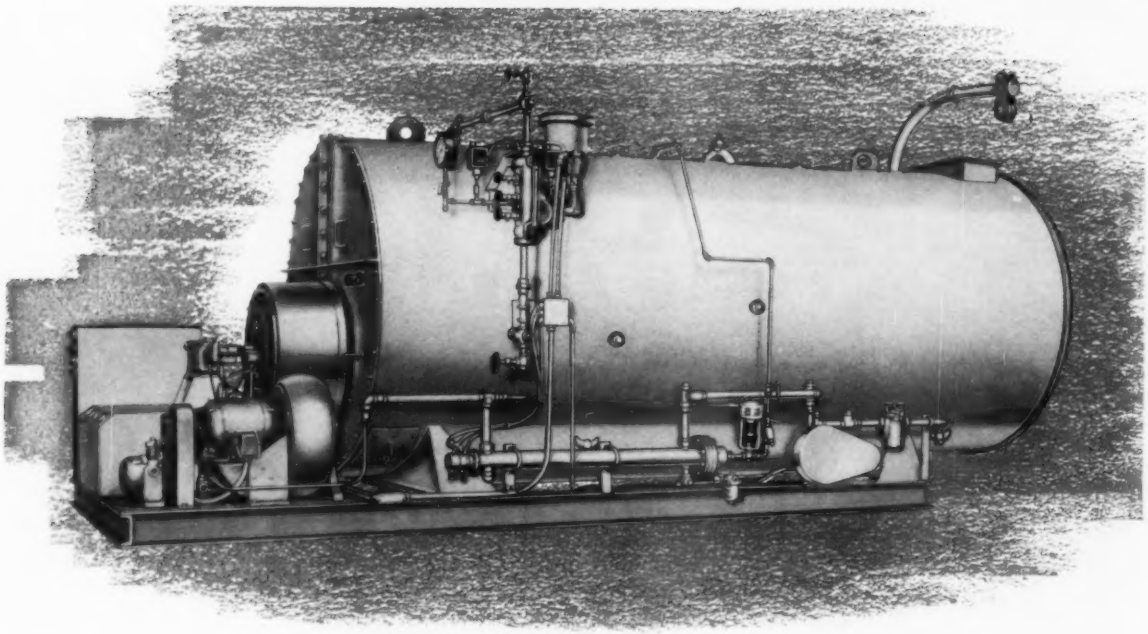

You can't buy them.....

Better Designed

Behind this Erie City "FT" package unit is the manufacturing skill and engineering know-how acquired through more than a century of producing large, high pressure, water tube and fire tube industrial power boilers.

The "FT" has five full square feet of heating surface (ASME basis) per developed horsepower. The 3-pass design places the gas vent at the rear where it belongs. Carefully proportioned gas areas through three lengths of the boiler take into consideration reduced gas volume as heat is being rapidly absorbed by the surrounding water. The "FT" is a pressurized unit using forced draft to provide precise control of excess air and CO_2 — no leakage of outside air into the combustion chamber is going to lower the efficiency.

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The same modern shop practices and quality workmanship used on our largest power boilers are used on these package fire tube steam generators. Every "FT" is of welded construction, stress relieved and X-rayed as part of the quality built into this unit. The "FT" is built for easy installation and complete accessibility. A full length, rigid, all welded structural steel base carries the entire package unit, permitting quick and easy installation anywhere without the use of skids and without excavation or foundation work. The front and rear heads are constructed of insulated, sectional panels for complete accessibility to the tubes and combustion chambers.

Every Erie City "FT" is built to highest quality — not down to a price.

Better Serviced

Every "FT" is designed, built, assembled, piped, wired and *Factory Fire Tested* by Erie City Iron Works. A complete package steam generator ready to go to work when it reaches the customer's plant.

A *factory trained* Erie City field service engineer will supervise the initial start-up and will instruct the operating personnel in the proper operation of the unit. This feature of using *factory trained* service engineers plus *Factory Fire Testing* results in a correctly adjusted, efficient steam generator.

Investigate all the advantages of the Erie City "FT" package fire tube. Catalog literature is available and an Erie City District Sales Agent will be pleased to show you an "FT" in operation.

For the quality fire tube package "FT" — write for Catalog 5682-H

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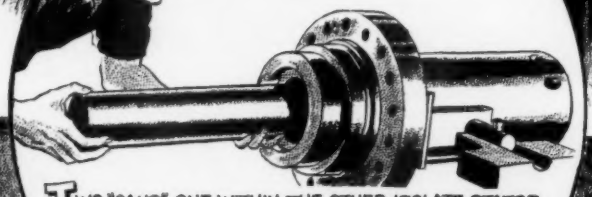

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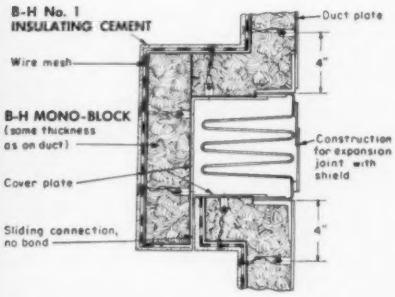

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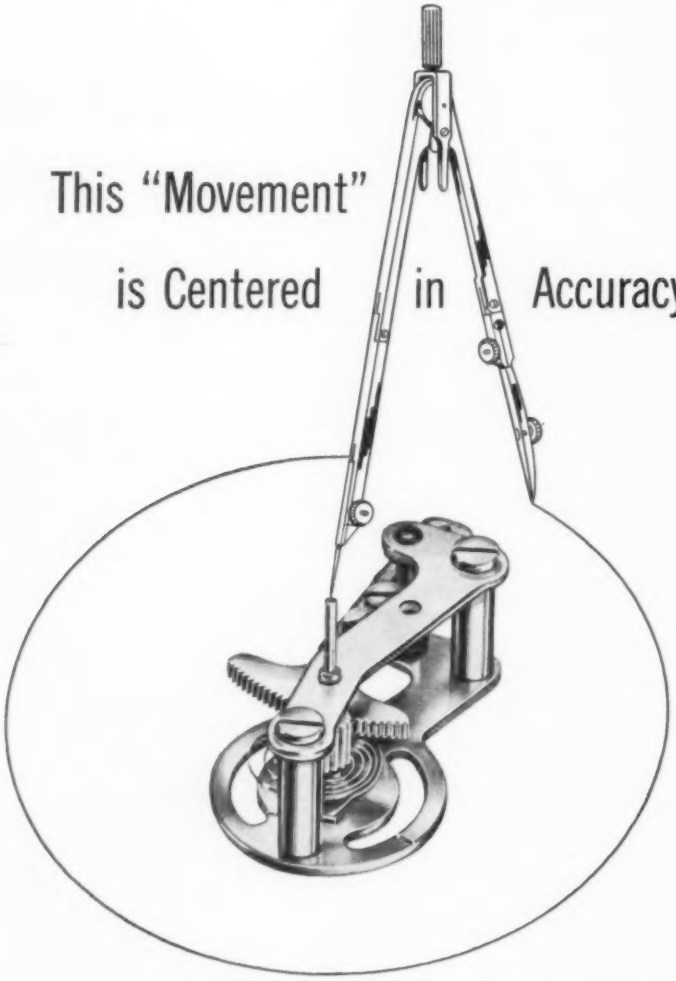
This "Movement" is Centered in Accuracy



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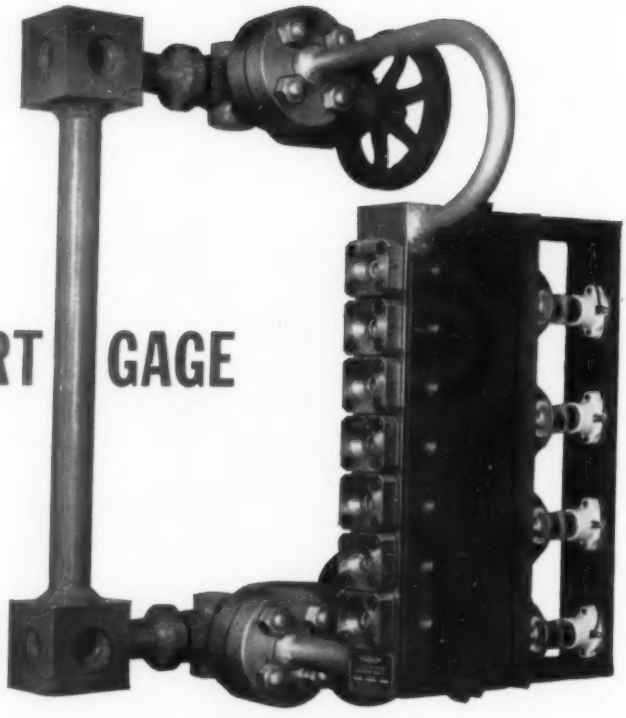
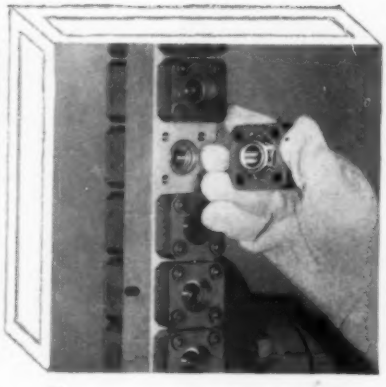
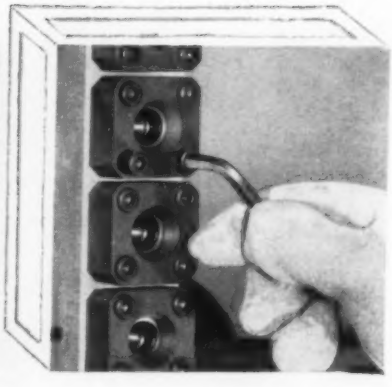


a Remove four cap screws and lift off cover assembly (held in right hand). Install new port assembly (glass-mica-gasket, shown in left hand) in cover. This port assembly is part of the complete cover assembly.



b Re-install complete cover assembly. Sealing gasket automatically seats in gasket groove in body.



c Tighten down four Allen cap screws with standard wrench (no torque wrench required).

New Yarway Color-Port Boiler Water Level Gages (for pressures to 3000 psi.) offer not only this new ease of maintenance but insure brilliant red and green readings of steam and water.

For full details, write for Yarway Bulletin WG-1814.

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TRACERS

Power Engineering's Monthly Probe of Power Facts

Stoker coke produced by a continuous process in conjunction with steam generation is reported by Island Creek Coal Co. Coking coal is fed continuously to a traveling-grate stoker operated at about double its normal speed. By control of air admission, volatile matter in the coal is burned to provide heat for coking and to raise steam, while most of the fixed carbon in the coal is recovered in the form of small-sized, porous, high-temperature coke.

New factor in today's power-making scene is ultra-pure water. Prime demand of nuclear power plants is feedwater purity measured in *parts per billion* instead of the usual ppm. It's a stringent requirement. For why and how, see W. A. Homer's article in ATOMICS, page 42 of this issue.

Nation's first steam turbine-driven generator with water-cooled stator windings is being built by General Electric. This design principle makes possible generator ratings conceivably as high as 1,000,000 kva. G-E's first use of water-cooling is in the 265,000-kva generators of a 450,000-kw, cross-compound steam turbine-generator unit for Philip Sporn Plant of the American Electric Power system, in W. Virginia.

Another "first" — a power transformer cooled and insulated by vapor or gas. It was energized the other day by Baltimore Gas and Electric Co at their Havre de Grace substation. Built by Westinghouse, the new unit is based on the use of fluorocarbons. Fluorocarbon liquid is distributed over the transformer coils and core by a pumping arrangement. Liquid vaporizes, absorbing heat of vaporization. Hot vapors then enter a cooling system in which the heat is removed and the vapor condenses back into a liquid, completing the heat transfer cycle.

Argument is that over-all cycle efficiency can be increased by including a gas turbine and using supercharged boiler with a new steam turbine installation. Also, water requirements and size of condenser are reduced; so is the size of many auxiliaries. Just how much — and for the ins and outs of the combined cycle approach generally — see J. O. Stephens' article, page 97.

New method for applying pure polyethylene to steel surfaces has been developed by Tank Lining Corp. Method preserves the plastic's excellent resistance to the corrosive attack of many chemicals. Expect to see it as a successful lining material for valves, tanks and pipe.

Extra high voltage — it's the key to power system development in Europe, where demand for electricity is increasing in every country; and it has begun, inevitably, to influence the shape of things to come in American electrical power transmission. Systems are now operating at 380 to 420-kv in Sweden, the USSR, Germany and France. The USSR is planning for transmission at 800-kv direct current. In the U. S. and Canada, use of 345-kv and 360-kv is rapidly developing. For a comprehensive world view of electrical power systems today, turn to the special report in this issue, pages C-1 to C-12. This is an account of the meetings held by CIGRE in Paris, France, in June. It was written for you by POWER ENGINEERING's Editor, Chester R. Earle, who flew to France for the purpose.

Fig. 1. View of mill, power plant right center. Note self-unloading coal vessel and coal storage pile. Water intake and pump house is near vessel's stern. Power plant supplies electric power, process steam and water, compressed air

New Abitibi Mill Makes the Most of Process Steam for Power

Power plant for new hardboard mill in Michigan burns wood waste as well as coal. Boilers supply both superheated steam for by-product power and saturated process steam simultaneously, latter on varying demand; utility tie-in; condenser cooling water to process

By **EDWARD H. BARRY** *

POWER PLANT serving Abitibi Corporation's new mill at Alpena, Michigan, is a good example of the methods used in coping with the steam and power plant design problems of a manufacturing industry.

The mill manufactures insulation board and hardboard from wood pulp. It is a completely integrated operation, starting with the pulpwood logs and ending with the finished products. Accordingly, there are requirements for electric power, process steam, compressed air and process water, all supplied by the steam power plant.

Early studies showed clearly the economic feasibility of generating a substantial block of power as a by-product of the use of process steam. However, the predicted demands for steam were of such a nature that it was apparent that not all of such steam could be used for power generation prior to its use in the process.

For example, one of the board presses requires saturated steam at temperatures of up to 500 F, for heating the multiple platens. The corresponding steam pressure is up to 750 psi. Saturated steam is also used in the pulp digesters at variable pressures up to 200 psi and in the screen-back press at 200 psi. These particular steam consumers have two characteristics in common. The steam must carry little, if any, superheat and the consumption is cyclic, with wide variations in rate from zero to high peak values.

Steam Conditions

Pressure of 750 psi is obviously too high to be considered practical, under the prevailing conditions, as a turbine extraction or exhaust pressure. Steam used in the screen-back press and in the digesters is suitable for extraction as far as pressures are concerned, but the swings in demand constitute a condition that makes it undesirable to draw steam from this point for that use. The swings are not only individually large and sudden, but they integrate to extremely large variations when the peak demands of the several consumers coincide during their operating cycles.

Because of these considerations, the process steam was divided into two classifications, in one of which it is unsuitable for extraction. Steam in the second category is used at relatively low pressures and uniform rates. Studies indicated the economy of generating power with both extracted and condensed steam.

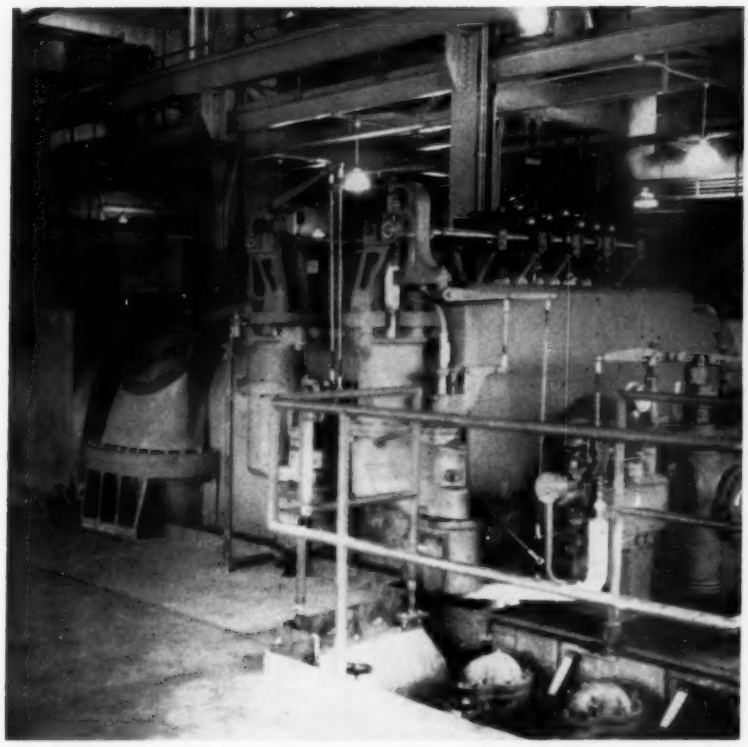
Final selection was a 6250-kw, automatic extraction-condensing turbine generator to operate with steam at 850 psi, 825 F. Extraction is at a controlled pressure of 300 psi. Condenser proved to be economical, principally because of the comparatively large requirements of the mill for warm process water, which could be used initially for condenser cooling. Turbine generator normally operates at base load running in parallel with power purchased from the local public utility.

Steam is generated in two coal-fired and process waste-fired boilers, each equipped with continuous ash discharge spreader stoker and pneumatic waste fuel feeders. Waste fuel consists of hogged wood bark and fabricating trim. The latter, being light and dry, is conveyed pneumatically over a distance of several hundred feet from the mill to live bottom bins in the boiler house.

Bark is transported from the barker house to a hopper adjacent to the boiler house. It is then conveyed by elevator and horizontal conveyor to the same waste fuel bins. Coal is received in self-unloading boats, spread over an outdoor storage pile and reclaimed by a belt conveyor, crusher, bucket elevator and distributing conveyor above the station coal bunkers.

Boilers are each equipped with

* Stone & Webster Engineering Corp



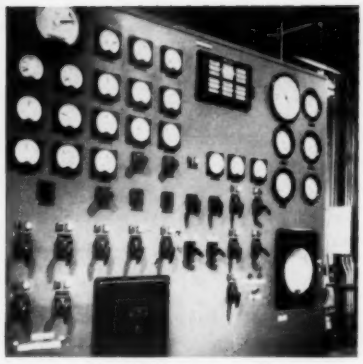


Fig. 2. Control board for the 6250-kw automatic extraction-condensing turbine generator (850 psi and 825 F)

Fig. 3. Turbine generator, showing main and extraction governors. Operates at base load running in parallel with purchased power. Extraction is at a controlled pressure of 300 psi

water-cooled furnace, superheater and economizer. Each boiler is also served by single forced and induced draft fans, overfire air fan, fly ash collector, fly ash return system and furnace ash removal system. Single stack serves both boilers.

Unusual feature of the boilers is the provision for removing both saturated and superheated steam simultaneously. Ability to remove saturated process steam directly from the boiler steam drums reduces the amount of required desuperheating and thus permits the limited use of spray-type desuperheaters using boiler feedwater as the cooling medium. Automatic regulators maintain a safe ratio between the flows of saturated and superheated steam in order to protect the superheaters against overheating.

Boiler feed system consists of a deaerating feedwater heater, two full capacity boiler feed pumps and an automatic feedwater regulator at each boiler. Mill condensate returns, as well as turbine condensate, are pumped to the deaerating heater, which also receives softened make-up water as required. This heater also receives flash steam from the continuous blowdown system and, as required, steam extracted from the turbine.

Furnace ash is conveyed to an outdoor storage silo by means of a steam-pneumatic ash handling system. Ash is discharged from the silo into trucks by way of a dustless unloader.

Raw boiler make-up water, originating in Thunder Bay River, is treated by a process employing a hot-lime reaction tank and sodium zeolite softeners. As a secondary treatment, morpholine and sodium sulfite solutions are added to the feedwater at the suction of the boiler feed pumps in order to control the action of dissolved oxygen and carbon dioxide. A tertiary treatment consists of the addition of a disodium phosphate solution directly to the boiler water.

Fly Ash Injection

An interesting feature of the fuel-burning equipment is the method of returning collected fly ash to the furnaces in order to recover and burn the combustibles. Instead of injecting the fly ash into the furnace with conventional high velocity injection nozzles, the fly ash is deposited by gravity on the rear portion of the forwardly moving grates.

Fly ash, which accumulates in the hoppers under the dust collector, is removed by pneumatic vacuum nozzles and transferred to a group of small cyclones mounted outside the rear furnace wall and immediately above the projecting rear portion of the grate. Excess transport air is relieved into the main collector and the separated ash flows continuously by gravity from these cyclones to the grate. As the grate moves forward, fresh coal, which is thrown to the rear of the grate, tends to blanket the layer of fly ash and prevent it from being blown into the furnace proper.

Fig. 4. Front view of one of the boilers, showing spreader stoker. Waste fuel feeders, invisible here, are located behind non-segregating coal spout

It is expected that this method of returning fly ash to the furnace will reduce the erosive effect of fly ash on boiler surfaces, due to the lower dust loading of the combustion gases, will reduce the unburned carbon loss and will reduce slag formation on the furnace refractories, especially on the front wall.

Centralized Control

Control of the two boilers is centralized at an instrument and control panel. Combustion control is fully automatic except for the feeding of the waste fuels.

An automatic oxygen controller at each boiler, sensitive to oxygen in the exit gases, applies a corrective impulse to the fuel-air ratio controller. This type of control was adopted since the optimum fuel-air ratio is not constant because of the varying proportions of the two waste fuels and the unpredictable rates at which they are fed. These instruments indicate and record also the percentage of combustibles in the gases.

As mentioned above, automatic controls are provided at each boiler to prevent the withdrawal of excessive amounts of 900 psi saturated steam taken directly from the steam drums. Such withdrawals automatically cause an increase in coal-feeding rates which, if not accompanied by a corresponding demand for superheated steam, would result in overheating the superheater.

Metering orifice on the regulating valve operated by a pneumatic diaphragm is installed in the saturated steam lead from each boiler. Flow through each superheater is also metered. Differential pressures across each pair of orifices are combined in a ratio controller which transmits a controlled air pressure proportional to the amount of departure from the flow ratio. Pressure is applied to the diaphragm of the regulator valve.

An overriding third element of the control, which is sensitive to superheated steam temperature, corrects the control air pressure to restrict further the flow of saturated steam when the superheated steam temperature exceeds a preset maximum. Any deficiency in the supply of saturated steam to consumers is made up by superheated steam taken from make-up valve and spray desuperheater.

Thermodynamic properties of 900-psi saturated steam are such that in passing through a pressure-reducing valve, partial condensation of the steam occurs until the pressure has been reduced to approximately 100 psi. Effect of this is that a relatively small amount of desuperheating water is required when superheated make-up steam is fed into the saturated steam line running to the mill.

As is frequently the case in industrial power plant practice, the steam plant at Alpena must supply exceedingly variable process steam demands. In doing so, it must operate with relatively large amounts of adequately conditioned boiler make-up water. In addition, it must burn the waste fuels as they are received.

Turbine room is of conventional design and except for the method of handling the condenser cooling water, presented no unusual engineering problems. As stated before, the mill process water is taken from the discharge of the condenser system.

At the present time, the mill requires about one-half the amount of water passing through the condenser. An intake structure and pump house are located at the river bank. Water enters the suction well through racks and a traveling screen. Pump house contains a fire and jockey pump, two circulating water pumps and a screen wash pump.

All water, except that in the fire system, is pumped to the turbine condenser which discharges into an open seal and transfer well located in the turbine room below ground level. Vertical process water pumps supply water to the mill from the seal well. Circulating water piping has been arranged so that the condenser may be bypassed if necessary. Because the quantity of the cooling water normally exceeds the process water requirements, an overflow has been provided on the seal well which drains by gravity to the river.

All process water is chlorinated continuously. In addition, chlorine solution is fed intermittently to the condenser cooling water at predetermined intervals on an automatically timed cycle. Purpose of such feeding is to control slime in the condenser. The power plant supplies both service compressed air and instrument air for the entire mill. THE END

Comparing Costs of Mixed-Bed and 4-Bed Demineralizers

WHEN IT BECAME necessary to install additional demineralizing capacity at its Huntley Station, Niagara Mohawk Power Co selected a four-bed system, since it was felt that the effluent quality would be equally satisfactory to the existing mixed-bed system, plus advantages in operating and maintenance.

The mixed-bed and four-bed demineralizers are each designed to handle 80 gpm, and each treats water from the Niagara River, after passage through separate but identical pretreatment systems.

Installed cost of the mixed-bed system, including the pretreatment plant, was $84,600, of which $41,885 was for the equipment. The four-bed system, purchased 2½ years later, cost $119,300 installed, including $47,963 for equipment. Installation cost of the latter was higher due to longer piping and higher labor rates.

The mixed-bed demineralizing system has been operating since January, 1954, while the four-bed system went into service in September, 1956. Careful records have been kept on the operation of each system, which provide a basis for cost comparison.

The following comparative analysis was given at the 1958 American Power Conference by Francis B. Wink of the power company and Durando Miller of the Permutit Co.

First of all, they analyzed the costs of regenerants for the system. Chemical costs for regenerating the mixed-bed demineralizers have averaged 21.8 cents per 1000 gal, while similar costs for the four-bed demineralizer have averaged 15.28 cents per 1000 gal.

Part of this difference is attributable to the fact that anion exchange is somewhat more efficient in an individual-bed unit, and part is due to reduced exchange efficiency of the mixed-bed, when resin becomes older.

Resin Replacement Costs

Anion resin in the mixed-bed units has been found to have a useful life of about 315,000 gal per cu ft. Cation resin in these units undoubtedly has longer life, but it is replaced at the same time as the anion resin.

Resin replacement costs for the mixed-bed units have been 27.4 cents per 1000 gal of water demineralized.

To date, the resins in the four-bed demineralizing plant have shown no signs of deterioration. Therefore, resin replacement costs are presently unknown. It should be noted that the primary anion resin has treated over 400,000 gal per cu ft, while the secondary anion resin has treated roughly three times this amount.

In an effort to reduce mixed-bed anion resin replacement costs, laboratory tests were carried out to determine effectiveness of various chemical treatments of the fouled resin. Salt brine plus hypochlorite treatment appeared to hold some promise of success, based on laboratory tests. This treatment was applied to the resin beds in each of the mixed-bed units. Much color was removed, but no improvement was found in effluent silica or conductivity.

Labor Costs

Since both installations are automatic, relatively little difference in labor cost has been observed. The figure has averaged 9 cents per 1000 gal for the mixed-bed system, and 8.5 cents per 1000 gal for the four-bed system. About 90 per cent of these labor costs are chargeable against the pretreatment systems, including recharging of chemical feeder tanks and effluent analysis.

Maintenance Costs

The mixed-bed demineralizer has had higher maintenance costs, primarily due to periodic labor for resin replacement. Cost has averaged 7 cents per 1000 gallons.

In 15 months of operation, the four-bed demineralizer had required very little maintenance other than some replacement of parts for the Saunders valves in the acid piping.

Fig. 1. L to r—Outgoing NAPE President Dudley Holmes with incoming officers Foreman, Cronkhite, Schuetz, Mitchell

Fig. 2. S. C. Crager accepts Strickler award from donor as Walter Lamb, Past President and Awards Chairman watches

NAPE Convention Stresses Education and Uniform License Laws

WITH ITS educational program and the long sponsored drive to attain uniform licensing laws throughout the United States spearheading the proceedings, the National Association of Power Engineers (NAPE) held its 76th annual convention June 2 to 6 in the Hotel Ambassador in Atlantic City.

Approximately 500 delegates, alternates, their wives and families attended the convention from the various chapters throughout the country.

NAPE was founded in New York in 1882 as the National Association of Steam Engineers and was reorganized into its present form in 1928 when the rapidly expanding scope of the power engineer rendered the original name obsolete. The intervening years have witnessed its growth from a relatively modest beginning to its present vigorous and expanding membership in excess of 15,000 in more than 180 chapters throughout the country. Attesting to the dynamic leadership and enthusiasm of NAPE is the fact that of this number, 25 charters were granted to new chapters during 1957, and the unanimous feeling among the national officers that this rate of growth will be exceeded in 1958.

High on the National Association of Power Engineers' list of objectives is the promotion of the NAPE-sponsored extension course on power plant practice, administered by the University of Wisconsin under the direction of Professor Paul J. Grogan, Associate Professor of Mechanical Engineering and head of the University Extension Division. (Professor Grogan is well known to POWER ENGINEERING readers through his many practical articles.)

Highlighting the convention was the presentation of the William C. Strickler award. This plaque is awarded annually to the chapter having the most outstanding record of achievement for the year and was won by New Jersey Chapter No. 17. Figure 2 shows S. C. Crager accepting the award for his chapter from the donor, William C. Strickler.

Ever energetic in their efforts to secure uniform licensing laws governing power engineers, the convention sat in rapt attention to an address explaining the procedures necessary to introduce and have enacted as state law, a bill governing the licensing of power engineers. The legislative committee has prepared a model law, copies of which may be obtained by interested parties from the association's national headquarters, 176 W. Adams St, Chicago.

Ranking high in interest on the convention's educational program was the presentation in two sections of a program titled "From Here—Where?". This was in the form of an illustrated lecture dealing with present design trends and the forms they are expected to take in developing the power stations of tomorrow. Section 1 was titled "Industrial Boilers — Today and Tomorrow" and was delivered by Arthur W. Jackson, supervising Engineer, Industrial Proposition Engineering Division of the Babcock and Wilcox Co. Jackson went quite deeply into the problems inherent in the design of an industrial boiler to meet the changing needs of the future, with a continuing demand for higher pressures and temperatures. Section 2, "A Look Ahead in Industrial Turbines," was presented by E. K. Nock, Manager of Industrial Sales, Medium Steam Turbine, Gear and Generator Department of General Electric Co. Both sections were admirably illustrated with color slides.

All business sessions of the convention were well attended, with the final session devoted to the election and installation of national officers. Elected to succeed outgoing National President Dudley Holmes of Magnus Chemical Co was Ivan J. Cronkhite, Superintendent of Power Plants for Sutherland Paper Co. Elected National Vice-president was Hugh Foreman, Special Sales Engineer for Southern California Gas Co. Edward Schuetz of the Boiler Licensing Division of the City of Milwaukee was re-elected National Secretary. Arthur B. Mitchell, Project Superintendent of the Chicago Housing Authority, was re-elected National Treasurer.

Climaxing the social program of the convention was the annual dinner-dance held in the Renaissance Room of the Ambassador. With Past National President Tom Barrett very ably handling the toastmaster's chores, several members of the convention were honored for outstanding contributions. Outgoing President Holmes was acclaimed for his extraordinary efforts during the year on behalf of NAPE's organizational program. Professor Paul Grogan was honored for the exemplary manner in which the NAPE-sponsored extension course was developed. Herman Paradis, Chief Engineer for the Anheuser-Busch plant in Newark was acclaimed for an outstanding job as advertising director of the convention.

San Francisco was designated host for the 1959 convention. THE END

Use of supervisory control equipment results in the combined advantages of manual operation and unattended stations, and helps to maintain service under emergency conditions by giving the central station operator a picture of the entire system at all times

How the Space-Code-Selector System

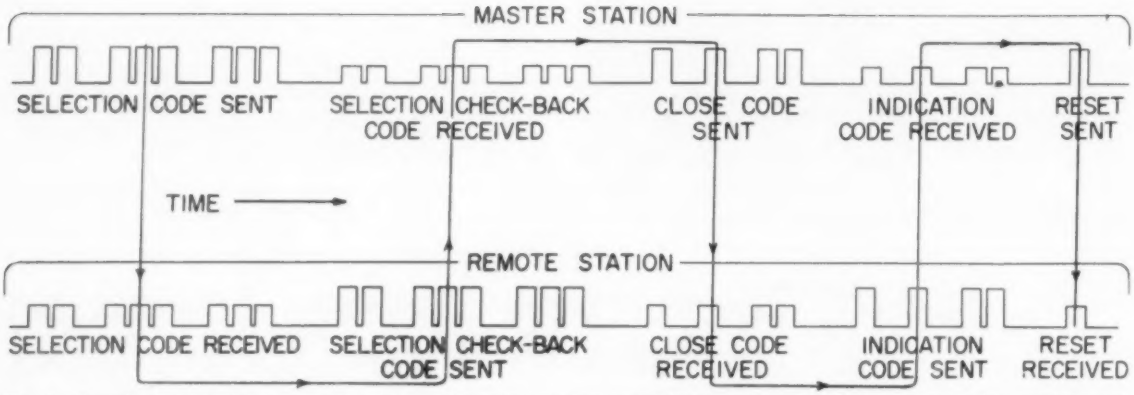


Fig. 1. Complete operating sequence using space-code-selector supervisory equipment. System uses codes consisting of definite number of pulses of uniform length, with time intervals between pulses. Complete sequence takes less than 3 sec

AUTOMATION of electric power systems and electrically-controlled apparatus is very closely related to and increasingly dependent upon the use of supervisory control, indication and associated telemetering equipment. Electric utilities recognized the advantages of remote control equipments and installed the forerunner of present-day equipments over thirty years ago. Today, these same utilities are operating complete hydro-generating stations and interconnected substations from central locations.

The survey made in 1953 by the AIEE Committee on Substations revealed that supervisory systems have found wide usage in present-day installations, and that there is an ever-expanding field for automation and supervisory control for installations of the future. Even more impressive was the confirmation by users that these controls were every bit as reliable as those furnished in attended stations.

In the past decade, industrial power systems have been increasing in size, complexity and importance. Their expansion has been similar to that experienced by the utilities, so little time elapsed before industry recognized the versatility and economics of centralized supervisory control and indication.

By description, supervisory systems are electrical equipments, similar to telephone and telegraph equipment, used to operate any remote apparatus equipped for local electrical control. A basic system consists of equipment at one or more remote locations, and similar equipment at a master or control center. Primary purpose of this equipment is to perform, selectively, a relatively large number of operations over a single interconnecting channel. These operations can be control, indication or telemetering functions, or combinations of these.

General Applications

Supervisory systems function somewhat like automatic dial telephone systems. In the telephone system a coded signal is generated and transmitted over a line to make a specific selection. This is possible since each telephone number is assigned a different code, and only one telephone number can be dialed at a time. Likewise, supervisory systems perform only one operation at a time over a single channel. However, instead of dialing a series of numbers, the code is more frequently generated by merely depressing a single selection key or push-button.

Operation by supervisory equipment is advantageous over direct-wire remote control, which requires separate control and indication wires for each remote unit, for installations where the distance between stations is such that the cost of installing and maintaining a multi-conductor control cable would be excessive. In certain instances, this equipment has competed favorably with direct-wire control within the confines of a large commercial building. Supervisory equipment may actually be lower in first cost and much simpler and more economical to maintain even though the distances are relatively short.

Also, this method has often been used for installations where direct-wire remote control could be economically applied, because its inherent safety features prevent faulty operations due to control cable faults or inductive interference which would be possible with direct-wire control.

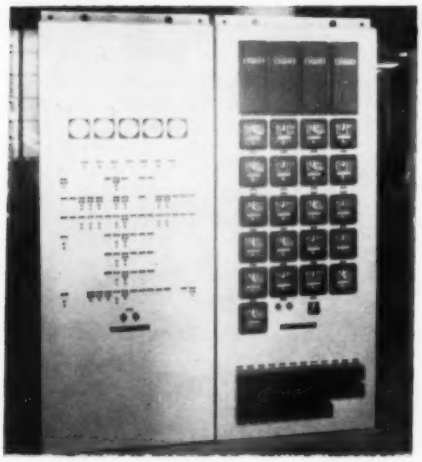
With supervisory equipment it is possible to control and supervise any piece of apparatus which has provisions for local electrical control. Its applications include automatic generating stations, unattended substations, large industrial plants, commercial buildings, municipal projects, and more recently, pipeline and petroleum industries. Any number of apparatus units in one or more remote locations can be controlled and supervised from any convenient location over a single interconnecting channel.

Probably the most common application of supervisory equipment is the closing and opening of circuit breakers and disconnecting switches and indicating their position. Other operations include the control of automatic reclosing relays on feeder breakers, resetting lockout relays, initiating automatic synchronizing, controlling gates and valves, changing taps on transformers, controlling

*Medium Voltage Switchgear Dept of General Electric Co, Philadelphia

By A. R. CHRISTMAN*

Works to Give Supervisory Control



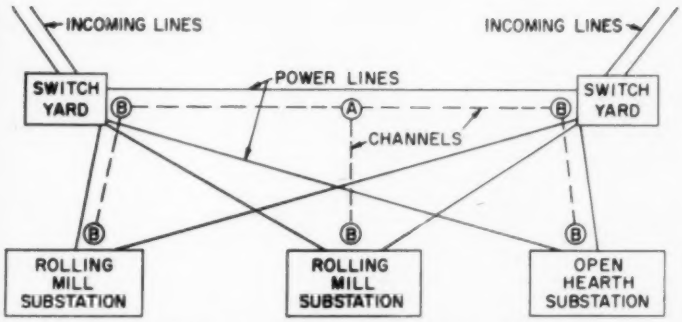


Fig. 3. Master station at A controls and telemeters switchyards and load-centers in typical steel mill layout. System holds outage time to a minimum

Fig. 2. Typical master and remote station supervisory equipments take up less floor space than conventional switchboards in industrial operations

exciter and generator field rheostats and selecting telemeter readings. These operations are initiated by the operator at the master station. Similarly, with this same equipment and over the same channel, the operator is automatically informed of any change or abnormal operation occurring at the remote station.

Types of Equipments

There are many different types of supervisory equipment available today. Some use coded pulses, others are basically electronic and still others are combinations of these two. The space-code-pulse type described here can operate over any type of channel that is suitable for voice communication or impulse transmission. It can use the most economical 15-pulse-per-sec type leased from a telephone company, privately-owned twisted-pair shielded cable or open wires properly transposed, power-line carrier, microwave, or even combinations of these.

Economic aspects often influence the choice of channels. When comparisons are made, however, the overall installation should be considered, including telemetering equipment, pilot relaying and any other aspects pertinent to the respective system. When making the selection, it should always be remembered that the system is no better than its interconnecting channel. Should conditions change after the equipment has been in operation, it is a relatively simple matter to adapt the supervisory equipment to the new channel. This means that changing from d-c-coded pulse to keyed audio-tone or carrier can be accomplished with minimum modifications.

Space-Code-Selector

This system is known as the Space-Code-Selector System. It uses a signal resembling a telegraph code, which is transmitted and received by circuits composed of telephone-type relays. While the telegraph uses short and long pulses, the space-code equipment uses codes consisting of a definite number of pulses of uniform length, with time intervals of either short or long duration between pulses. The short intervals are approximately the same length as the pulses, and the long intervals, which are designated as pauses, are approximately double this value. The number and location of the pauses in any series of transmitted pulses determines the codes.

A code consisting of two pulses could be shown as: Code 1 — —. Pulse 1 is on for one unit of time, and pulse 2 is on for one unit of time with one unit of time spacing between the two pulses. Thus, a code with a definite characteristic is established.

Again, if the same two pulses are used, but the time spacing between pulses 1 and 2 are doubled, a new code results. The increased time element is referred to as a pause.

If three pulses are used, the codes can be increased to four; and if four pulses are used, the codes can be increased to eight, like this:

Code 1 – – – –	Code 5 – – – –
Code 2 – – – –	Code 6 – – – –
Code 3 – – – –	Code 7 – – – –
Code 4 – – – –	Code 8 – – – –

It is therefore shown that for each pulse added to the code, the total number of codes is doubled. Five pulses will produce 16 codes; six pulses, 32 codes; seven pulses, 64 codes; and eight pulses, 128 codes.

The space-code-system is divided into groups. Each group contains eight codes. By assigning a code as shown above, to each unit in a group, and then adding pulses to represent the groups, the system can be expanded to an indefinite number. It should be noted, therefore, that the first four pulses of code 1, code 9, and code 17, for example, all look alike and that the subsequent pulses and pauses identify the groups, with code 1 being in group 1, code 9 in group 2, and code 17 in group 3.

This coded method of operation has been proved to be exceptionally reliable, because it provides a safeguard against incorrect operation due to interference external to the supervisory equipment. As mentioned previously, each code is made up of a definite number of pulses, and any distortion due to interference that would result in the loss or addition of a pulse would cause the equipment to reset. Since the code is determined simply by the spacing between pulses, the length of the pulse is not critical, and thus the lengthening of a pulse will not distort the code.

An important feature of the space-code-selector system is its check-back operation. This feature, which requires a selection code to be repeated by the receiving station equipment and checked at the originating station before an operating or indication code can be transmitted, is added insurance for reliable operation. The use of codes for the master control operations prevents interference on the channel from initiating a control operation after a selection has been completed and checked, which would otherwise be possible if single-pulse operating signals were used.

Thus to operate a remotely-located piece of apparatus (Fig. 1), it is necessary to initiate a selection code, have this selection code automatically verified, initiate the control operation which will be followed automatically by an indication code and reset operation. The complete operating sequence takes less than three seconds. This is a two-step operation which gives the operator a chance to ascertain that the correct selection has been made before he initiates a control operation. The selection check is indicated by the illumination of an amber select lamp associated with the point being controlled.

Another significant feature of this equipment is its built-in memory action. This is to insure that there will be no loss of indication. If an automatic change in position occurs simultaneously in the same or in different remote stations on the same system, the new position indications will be transmitted one at a time.

Likewise, if a change in position occurs while a selection or control operation is in progress, it will be stored and then transmitted after that point resets. If interference occurs while an automatic indication is being transmitted, the equipment will reset and the transmission of the indication code will start again. This will be continued until the transmission of the new indication code is completed.

Likewise, in case of a channel outage, indications of change of positions at the remote station will be stored and then transmitted sequentially when the channel is restored. The operator at the master station is in complete command and given preference at all times. To permit an operator to keep a log on all equipment under his control and supervision, the system includes a station check scheme by which he can sequentially check the position of each piece of apparatus whenever he desires.

The economics of supervisory control are made apparent by the fact that the equipment is compact, and therefore requires minimum space, and is easy and inexpensive to install. Even more important are the savings due to better utilization of manpower, and improved systems' operation. Centralized control and indication not only releases highly-trained personnel from operators' jobs, but these men can then be made available for more important positions in the over-all system operation.

Here are typical instances where Space-Code-Selector equip-

Fig. 4. Substation control: five substations are controlled from this master panel at Hartford Electric Light Co

Fig. 5. Hydroelectric: supervisory equipment starts and stops hydro unit, adjusts generator output, water level

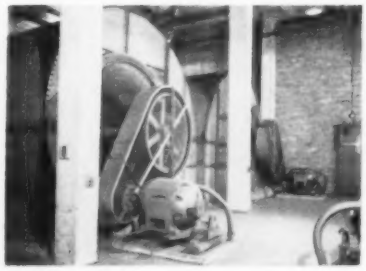


Fig. 6. Tunnel controls: master panel in George Washington Bridge monitors ventilating fans in tunnel approaches

Versatility of the equipment is demonstrated by the fact that it can be installed in locations most desirable to the user. It can be located indoors or outdoors, in line-up with other control or switching equipment, in vertical switchboards or benchboard arrangements. It is also ideally suited for solving load growth problems.

It is a recognized fact that even though considerable planning is done for a system, the best plans usually require revisions to keep abreast of continually changing requirements or developments. The supervisory system can be expanded to meet these new requirements without affecting the interconnecting channel. Its compatibility with communication, telemetering and data logging equipment extends its usefulness even further. And finally, the proof of the versatility of a system is what it can do and where it can be used. The following illustrations are typical of its many possible applications.

Industrial Power Application

As industrial power distribution systems grow more complex, so do the problems of controlling, indicating, and metering them. In many cases, supervisory equipment has solved these problems at lower cost than direct wire control, while taking up less floor space than conventional switchboards. (See Fig. 2.)

The supervisory equipment provides centralized indication of conditions throughout power distribution systems. If overloads or fault currents cause circuit breakers to trip out, the master control panel immediately reflects the condition. If conditions warrant, the breaker can be re-closed from the same panel. If the fault is more than momentary, a maintenance crew can be immediately dispatched to investigate the trouble, since its location is immediately apparent on the control panel. Outage time is thus held to a minimum.

Centralized control and indication, as shown in Fig. 3, as well as centralized trouble-shooting, is a major reason for using supervisory equipment in industrial applications. One operator can start and stop motors, open and close feeder breakers throughout the plant and control the load-tap-changer position of power transformers.

Utility Substation Control

In unattended substations, supervisory equipment is usually called upon to open and close circuit breakers and disconnecting switches, to adjust transformer or voltage regulator tap positions, to start and stop synchronous condensers, to telemeter various electrical quantities and tap positions, and to monitor a wide variety of alarm functions. Equipment checks of a complete substation are performed in a matter of seconds, assuring the operator that all is in working order.

If a master control panel (Fig. 4) indicates trouble at any substation, maintenance personnel can be dispatched to check the difficulty. Supervisory systems have been equipped to include a telephone for communication between the master and remote stations to facilitate maintenance and testing operations.

Hydro Station Control

Many of the functions performed by supervisory equipment at hydro-

ment is being used today for supervisory control

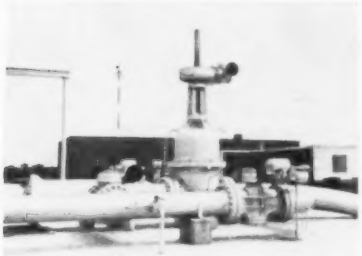


Fig. 7. Pipeline pumping station: supervisory equipment in this case uses a microwave channel (note antenna)

Fig. 8. Offshore oil production: master station storage platform controls, telemeters production for Phillips Petroleum

Fig. 9. Tank farms: valves associated with storage tanks in refineries are controlled with supervisory equipment

generating stations (Fig. 5) are similar to those in substations. From the masterstation, the supervisory equipment starts and stops the hydro unit, adjusts generator output and voltage level, and controls and telemeters water level and gate position. As in unattended substations, circuit breakers and switches on the same channel are remotely controlled, their positions indicated and a wide variety of electrical quantities telemetered and monitored. Where hydro installations are linked to irrigation systems, the supervisory equipment is also utilized to control flood gates and pumps.

In Commercial Buildings

Supervisory equipment has been installed and operated more economically than a direct-wire system for the control of power distribution on commercial buildings even with both the master and remote stations installed under one roof.

For instance, a new power distribution system installed by the New York Telephone Company in its Buffalo office is controlled by a 64-point supervisory equipment. In this installation, duplicate master control stations were furnished near each center, so that all 39 air circuit breakers in the three load centers could be controlled from any of the three locations. The positions of the breakers are shown by indicating lamps, and audible alarms call the attention of the operator to any unusual system condition.

Tunnel Controls

Ventilation systems in the approach tunnels to the George Washington Bridge in New York (Fig. 6) are controlled by space-code-selector supervisory equipment, as are the various other mechanical and electrical systems necessary to the proper functioning of the structures. The interconnecting channels consist of telephone wires running across the bridge.

Master control panel in the Bridge Administration Building provides continuous readings of the carbon-monoxide count in both tunnels and sound an instantaneous audible alarm to signify the need for increased ventilation. Automatic audible signals also indicate the opening of circuit breakers as well as the operation of burglar and door alarms in the ventilation buildings.

Operating characteristics of fan motors and pumps, together with high water levels in tunnel sumps and building storage tanks, are automatically indicated by signal lamps on the control board. Fire alarm and traffic emergency signals activated in the tunnel proper are also indicated on the board by signal lights. With the installation of the supervisory equipment, 75 per cent of the personnel formerly required to operate the tunnel equipment was released to perform more important operating and maintenance work.

Water Supply and Pipelines

For water supply and irrigation systems, supervisory systems have been used to stop and start pump motors and control their speed, to open and close electrically-operated valves, to telemeter pressures and flows, and, in large installations, open and close breakers on the power distribution system.

Supervisory equipment is ideally suited to the control and centralized operation of long distance petroleum and gas pipelines. Through its use, more pumping stations (Fig. 7) are of unattended variety. Supervisory equipment also helps reduce system down-time and increases the utilization of installed facilities through centralized programming of system operations.

With space-code-selector supervisory equipment, pump motors and valves at unattended pumping stations literally hundreds of miles away from the controlling point are operated in a matter of seconds by a single operator. In addition, supervisory with selected or continuous telemetering gives an accurate composite picture of conditions all along the pipeline. Temperatures, pressures, rate of flow, and oil level in tanks are all read from the control panel at the master station. Supervisory equipment also changes the set points on regulators, and monitors alarm points.

Automatic sequences are easily controlled by supervisory equipment. One point at the master station is used to stop or start an automatic sequence and additional indicating points are used to indicate the progress and position of the automatic sequence as it goes through its cycle.

The same supervisory equipment which controls pump or compressor drives and valves also maintains a constant check on all the auxiliary equipment at the pumping station.

Remote Station Control

If desired, remote stations are returned to manual control by operating a local-remote switch when maintenance or inspection requires. The master control panel often is designed to indicate the locked position on remote station gates so any tampering will be called to the operator's attention. Telephone communication is sometimes provided over the same interconnecting channel for use when a crew is working on the system.

Offshore production is controlled, indicated and telemetered using supervisory equipment similar to that supplied for pipelines. Figure 8 shows one of these platforms. In this system, both the master station and the remote station are located on offshore platforms and use a metallic interconnecting channel.

Tank farms with several tanks remotely controlled have also been economically accomplished using supervisory equipment (Fig. 9). Although direct-wire has been the common method for controlling filling pumps and valves in the past, with an increased number of controlled points, supervisory equipment has proved to be less expensive. THE END

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New College Heating Plant Switches to BCR Coal-Pak Units

When Otterbein College in Westerville, Ohio, decided to scrap its old heating plant, it based the new layout on automatic coal-fired packaged boiler units. Savings in fuel and labor costs have resulted

By SANDERS A. FRYE*

DECISION to scrap the old heating plant at Otterbein College was prompted by an opportunity for simultaneous solution of a number of problems which had been burdening the college.

Expansion of the college had increased heating load beyond the capacity of the two stoker-fired Brownell fire-tube boilers of 207 (nominal) boiler horsepower capacity. In addition, the old plant was not large enough to permit installation of a third unit without structural additions.

While the old boilers were less than 20 years old and operated satisfactorily, they were not fitted with automatic combustion controls. Stoker hoppers were manually filled and ash removal depended on the wheelbarrow. This obsolete practice required the full time of an operator when the plant was under load.

Another factor favoring the new plant was the condition of the steam heating circuit which a recent engineering survey showed was deteriorated to the point where complete overhaul was imminent. Consulting engineers had recommended that the college convert to hot water heating to free itself from expensive maintenance of steam traps and condensate lines.

Idea of a new heating plant was particularly acceptable because it opened the way to remove one of the campus eyesores. The old plant was situated near the administrative building where for years it kept alive a continuing stream of suggestions for a more appropriate location of college utilities.

For our new steam generating units we turned to the latest product of the coal industry — the completely automatic, packaged coal-burning boilers recently developed by Bituminous Coal Research, Inc, and known as the BCR-International Coal-Pak units.

Our new plant is equipped with three 200 (developed) boiler hp units and is used to heat 23 buildings which are scattered over the 40-acre site of the college. One boiler is tied into a conventional steam heating system and supplies the heating requirements of two buildings. The two other units serve a newly installed low temperature hot water circuit which serves the remaining 21 buildings of the college.

The simplicity of installation, efficiency of the automatic combustion controls and the labor-saving features of the coal and ash handling system proved themselves the moment the plant was placed on the line late this spring.

On the basis of our brief operating experience thus far, we anticipate that next year's fuel requirements will be 800 tons, or 200 tons less than the tonnage burned in the old plant. Particularly gratifying will be the labor-saving benefits from the automatic combustion controls and the coal handling and ash disposal systems. After the college is fully converted to hot water heating, the operator required by Ohio law for steam boilers will no longer be tied to the boiler room but will be able to devote most of his time to work in the maintenance shops situated in the same building.

Unique design of these new steam and hot water generators is the result of $3\frac{1}{2}$ years of research and development effort at Bituminous Coal Research. After successful completion of tests on a prototype, designs were turned over to the International Boiler Works Co, which is the licensee for the BCR Coal-Pak Automatic Units.

Particularly notable is the compact arrangement of the coal and ash handling components, the combustion air supply system with its overfire air ducts, and the baffling of the heating surfaces which allow for a long gas passage.

Choice of Fuel

Choice of coal as the fuel for the new plant was never seriously in doubt. On the contrary, the fact that the BCR units were specially tailored to burn coal made the units especially attractive in an area where the cost of No. 6 fuel oil is currently running 1.83 times the cost of coal on an equivalent Btu basis, and the cost of natural gas 1.70 times.

*Business Manager, Otterbein College

Fig. 1. Front view of Coal-Pak units at Otterbein College heating plant. Coal passages are completely enclosed and sealed tight, preventing fines or coal dust filtering through

Fig. 2. Rear view of Otterbein units showing arrangement of forced and induced draft fans, and integral ash conveyors which discharge to the subfloor ash removal screw conveyor

Otterbein College
BCR-International Coal-Pak Design Data

Horsepower (Developed)	200 per boiler
Sq ft EDR (steam)	28,000 " "
Sq ft EDR (water)	44,800 " "
Btu output per hour (1000's)	6,700 " "
Heating surface, sq ft (ASME)	1,000 " "
Coal-feed capacity (13,000 Btu/lb, dry) lb coal per hr	687 " "
Water content to waterline, gal	800 " "
Maximum coal size, in.	1¼
Over-all length	22 ft–0½ in.
Over-all width	7 ft–4¾ in.
Over-all height	10 ft–6½ in.
Cleanout doors: Number	3 per boiler
Size	18 by 45 in.
Shipping Weight, lb	33,000 per boiler

Fig. 3. The 24 by 51-ft ramp above coal bunkers permits on-grade loading of bunkers and provides a convenient area for storing an additional 250 tons of coal

The 50 by 50-ft boiler room is on the lower level of a combination maintenance building and heating plant. The building itself is situated away from the main college complex on a hillside, which allows for on-grade delivery of coal to the bunkers and at the same time provides ample daylight and ventilation for the boiler room. Upper floor of the building serves as the college maintenance shop where plumbing, heating, carpentry, painting and auto repairs are carried on. Space is also available for garaging college automobiles, trucks and lawn mowing equipment.

Boiler No. 1 is operated at 3 psi and is used to carry the steam heating load of 14,000 sq ft EDR (steam) installed in two buildings in which the heating circuit is still in good condition and did not warrant reconditioning. It is planned to convert these remaining buildings to hot water heating sometime in the future. At such time No. 1 boiler will be converted to hot water heating. Under maximum winter load conditions, it is anticipated that No. 1 boiler will operate at 50 per cent steaming capacity.

Boilers No. 2 and No. 3 serve the new hot water heating circuit used to heat the remaining 21 buildings of the college. The boilers deliver hot water at a temperature of 200 F to the various buildings via tunnels. At maximum winter heating load the hot water boilers will operate at approximately 75 per cent load. The entire plant has a 50 per cent reserve capacity to take care of the future.

Figures 1 and 2 show the uncrowded and well-lighted arrangements at the front and rear ends of the Coal-Pak units.

Design Experience

From the time the coal leaves the overhead bunkers to the time the ash is discharged into the subfloor ash disposal conveyor, the combustion and heat absorbing operation takes place in what is virtually one piece of equipment. The coal-fired hopper, the unique pulsating grate, the ash removal conveyor, induced draft and forced draft fans and the complex of dampers, timers and combustion control actuating mechanisms were designed, built and assembled in the shop of one manufacturer and were shipped as one unit.

Choice of the Coal-Pak units made it possible for the plant designers to bypass many time-consuming studies which in the design stage of a conventional heating plant must be devoted to the sizing and selection of steam generator components and auxiliaries. Responsibility of the plant designers terminated at the overhead bunker outlet and commenced again at the inlet to the subfloor ash disposal system.

Only other design points critical to the generating units were the outlet of the boiler steam and hot water outlet nozzle, the feedwater inlet, and the inlet to the breeching. The entire complex area of responsibility between these points was transferred by the single decision to the designers and manufacturers of the fully packaged generators.

During the contract stage of the plant another notable simplification was evident by the elimination of the need to consult and negotiate with the representatives of many individual manufacturers.

It was during the erection of the plant, however, that the advantages of a fully-integrated automatic boiler, with its guarantee responsibility focused on only one manufacturer, were the most impressive. All that the erection operation involved was connecting the units to the five basic terminal points of the boiler, the overhead bunker outlet, inlet to ash disposal conveyor, breeching inlet, feedwater inlet and boiler outlet.

Coal Handling

A notable feature of the Otterbein installation is the design of the coal handling and ash disposal system. This utilizes to maximum advantage the automation features of the Coal-Pak units. Each unit is fed directly from an overhead coal bunker having a capacity of 30–35 tons of coal, or enough to supply No. 1 boiler for a 10-day period and the hot water No. 2 and No. 3 boilers for a six-day period operating at maximum load.

Coal from the overhead bunkers is received in the generator hoppers from which it is transferred into the furnace by means of 5-in. diameter screws. The screws provide a positive and measured coal feed and serve as effective barriers against burnback.

Each unit is fitted with four feed screws which move the coal through screw tubes of one flight length terminating in a refractory-lined vestibule outside the front water leg of the boiler. The screws are turned, alternate one in the opposite direction, at 7½ rpm by the same motor that drives the stoker cam shaft, thus fixing the synchronization between grate and screws.

As the coal leaves the screws, the pulsating grate distributes it over the grate surface and moves a 4-in. thick bed of fuel into the furnace. Bed moves gently down a 14 deg inclined grate. Grate bars rest on water tubes which are connected with the circulation system of the boiler, and are thus protected from overheating.

In addition to the 100 tons of coal storage in the bunkers, 250 tons can be stored on the loading ramp above bunkers. This ramp is 24 ft wide and 51 ft long and has a 4-ft high wall along the rear and side. Bunkers and ramp provide a storage capacity of approximately one half of the seasonal coal requirements of 800 tons and allow ample flexibility in the purchase and delivery of the fuel supply.

The plant uses Leatherwood Seam East Kentucky 1¼ modified, 30 per cent ¼ x 0 coal, which is hauled by truck and supplied by a local coal dealer. THE END

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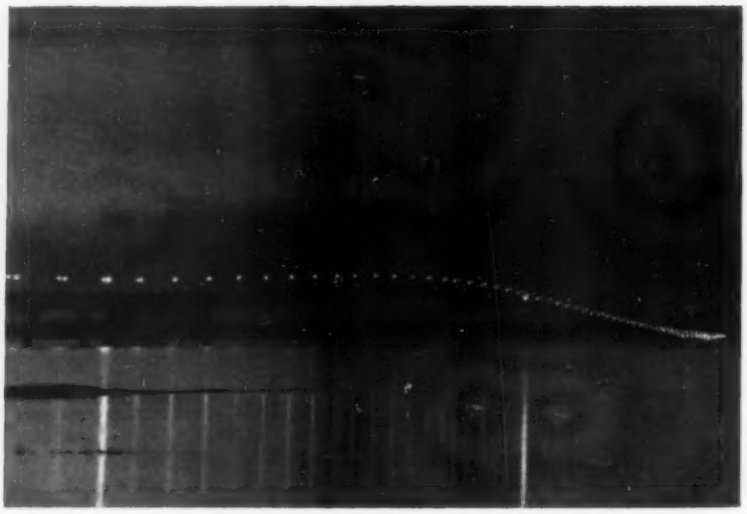

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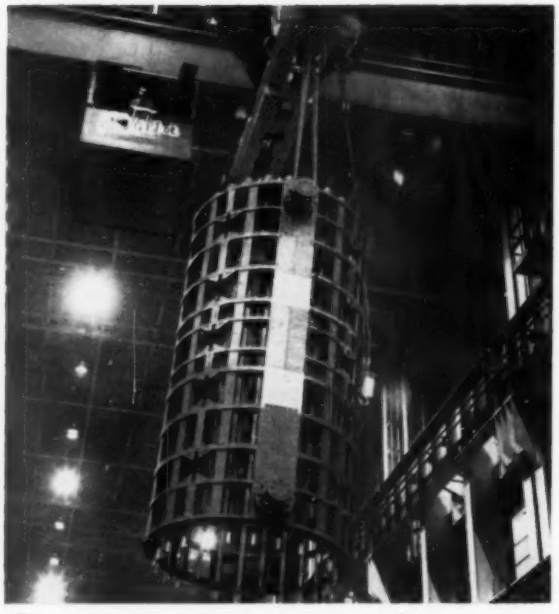

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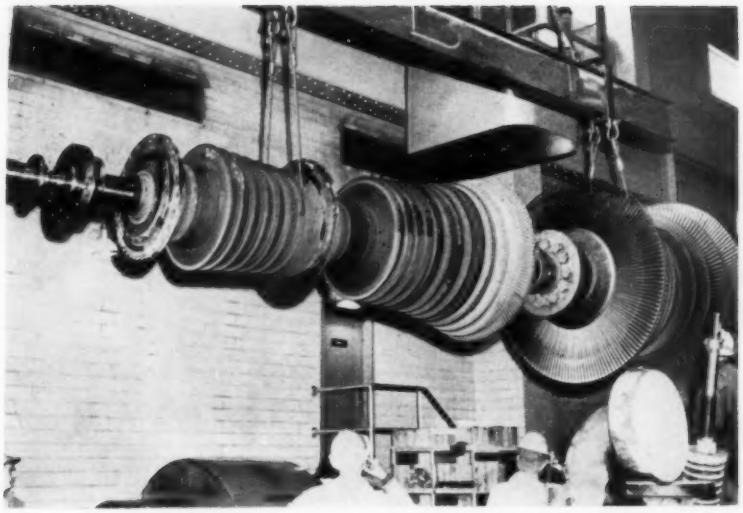
Power Engineering's

1 Gas recirculating fans which will each handle 251,000 cfm of 715 F gas are the largest yet used for this service. They were made by American Blower for Detroit Edison's St. Clair Station, to serve a B&W boiler of 2,100,000 lb/hr capacity. Shown are housing and 6-ton wheel

2 New bridge spanning Straits of Mackinac is the world's longest suspension bridge. Electrical service built into it uses 140 miles of wiring, for traffic control, lighting, power cables, beacons, telephone. Pittsburgh Standard Conduit supplied the almost 19 miles of conduit to protect wiring

3 Paris bound, Chester R. Earle, editor of POWER ENGINEERING, and Mrs. Earle, board plane at Midway Airport, Chicago. They are on their way to the 17th biennial meeting of CIGRE, the international conference on large high-tension electric systems. Over 1700 power engineers attended the sessions in Paris, June 4–14. See Earle's report, page C-1.

4 Gigantic bird cage is actually the steel inner cage portion of an electric power-producing generator. Made by General Electric, the 35-ton cage is over 26 ft long, has diam of about 10 ft, will be part of a turbine generator capable of producing some 156,250 kw—enough power to satisfy the average yearly electrical needs of over 260,000 homes



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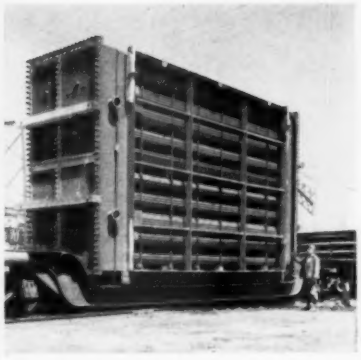

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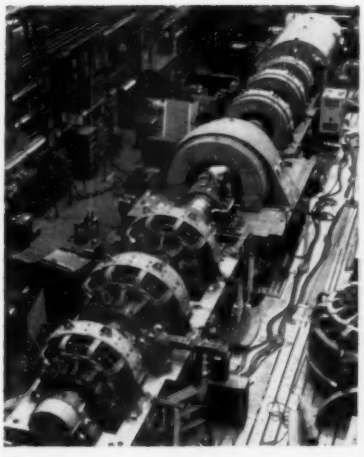

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NEWS REEL

5 It operated 27,200 hours at a constant rate of 3600 rpm, or 5,875,200,000 revolutions, before being dismantled for overhaul. It's a 22½-ton rotor, here being raised from 70,000-kw steam turbine at Lovett Plant of Orange and Rockland Utilities in N. Y. Output was 1½ billion kwh

7 Power is transforming the "lost world" area south of the Orinoco in Venezuela. An industrial complex which includes steel mill and hydroelectric plant is taking shape near the new town of Puerto Ordaz. This view shows the Macagua dam under construction on Caroni River. It will produce 300,000 kw for steel mill being built nearby, government owned

6 Condenser, completely tubed, leaves Allis-Chalmers plant in Wisconsin for Otter Tail Power Co in Fergus Falls, Minn. It's largest A-C condenser shipped with tubes installed. The 30,000 sq ft, two-pass unit has 5460 tubes each 24 ft long, will serve a 53,500-kw reheat steam turbine

8 Motor-generator for a U. S. Steel Co plant extends a record 86½ ft, is rated at 13,500 kw. Made by Westinghouse, the equipment will be used to drive a 12,000-hp twin-drive mill motor and 4000-hp edger drive motor which will operate the slabbing mill at the Gary Works in Indiana. The set has four 2500-kw and two 1750-kw d-c generators

Fig. 1. Section of boiler tube showing results of intergranular oxidation

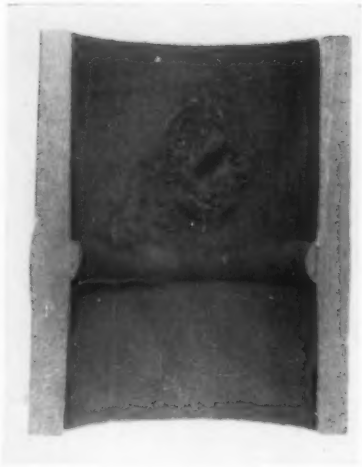

Fig. 2. Reaction products forming above back-up ring caused magnetite plug

Fig. 3. Cross-section of Fig. 2 tube shows penetration of magnetite plug

Single-Stage Copper Removal Treatments Lengthen Boiler Tube Life

New cleaning technique uses inhibited acid that prevents dissolved copper from plating out of solution onto the boiler tube surfaces

By J. P. ENGLE*
and R. W. FITZGERALD*

USING A NEW, single-stage, chemical cleaning method for removing both iron and copper deposits from boiler tubes has effectively reduced tube failures. This new cleaning technique is basically a conventional, scale-removal treatment, using inhibited acid containing a special complexing agent that prevents dissolved copper from plating out of solution onto boiler tube surfaces.

Most boiler tube failures apparently result from localized overheating caused by internal tube deposits. Such deposits may result from one of the following factors: 1. copper plate; 2. suspended solids (in boiler water); 3. interior tube projections (such as those at tube junctions); 4. surface imperfections (such as draw lines or surface inclusions); 5. differential thermal cells.

Copper Plate

Copper apparently is deposited initially upon clean metal surfaces. Irregularities or loosened flakes then serve as focal points for the evolution of steam bubbles. These bubbles result in localized concentration of alkali salts, eventually building up to concentrations that attack the tube. Intergranular oxidation and caustic embrittlement are produced by such attacks. The results are shown in Fig. 1.

As oxidation continues, an oxide layer builds up beneath the original layer of copper. The more voluminous oxide forces itself out through the copper plate, producing a deposit which is an irregular mixture of copper and iron. This spongy deposit retains relatively stagnant boiler water near the metal surface, forming concentration cells that accelerate the corrosion process. Eventually a plug of magnetite is formed. Resulting hot spots may then locally modify the tube's crystal structure, making the metal more susceptible to corrosion attack. Such modified crystal structure can be seen in Fig. 6.

Suspended Solids

Deposits on vertical tube walls are sometimes caused by prolonged contact with suspended particles. When such solids are heavy enough that their rate of fall through the upward rushing boiler water is equal to the thrust of the water, they may remain stationary in contact with the tube wall. Additional particles strike the obstruction, join with it, and a deposit gradually builds up. These deposits serve as focal points for bubble formation, producing alkali concentration. As in the case of copper deposits, such alkali in turn converts tube metal to magnetite. Usually these conditions produce only shallow magnetite areas.

Interior Tube Projections

Any interior tube projection can act as a focal point for steam bubbles, with resulting alkali concentration. The mechanism here is similar to the one just described. Deposits accumulated on such projections or ledges produce alkali concentration and resulting metal attack. Weld splatter often forms a ledge for solid particle accumulations. Backup rings may also act in this manner, as shown in Fig. 2. Depth of penetration of the magnetite plug shown in this photograph may be seen in the cross-section shown in Fig. 3.

Surface Imperfections

Such imperfections, such as draw lines produced during the manufacture of tubes, or stressed areas resulting from turbining, also make for corrosion and resulting deposits that may weaken the tube.

Differential Thermal Cells

Differential thermal cells may be set up within boiler tubes, producing galvanic corrosion. The electromotive force results from difference in temperatures at different points on the tube. For example, a studded tube may be much hotter on the fire side than on the side embedded in refractory. The fire side will then show an initial attack and deposits may form readily. Severe thinning may result on the stud side of a vertically-operating tube. Such thinning can be seen in the tube cross-section shown in Fig. 7.

*Dowell Division of The Dow Chemical Co

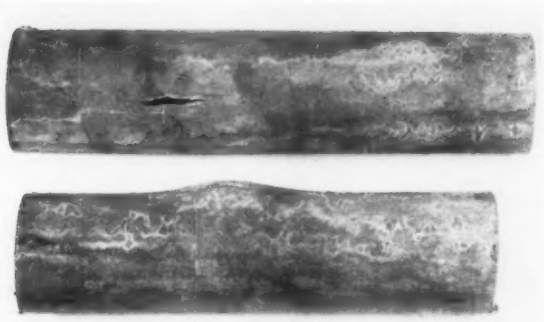

Fig. 4. Tube ruptures such as this are believed to result primarily from localized attacks begun by copper deposits

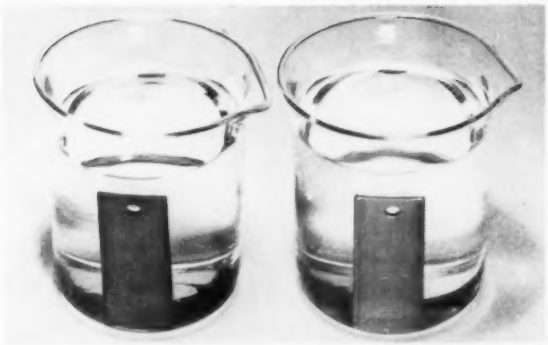

Fig. 5. Although steel strip in left beaker became heavily plated with copper, additive agent (r) protected strip

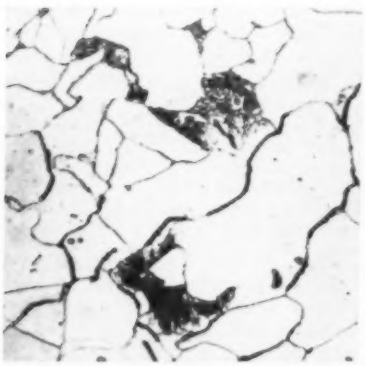

Fig. 6. Modified crystal structure resulting when a hot spot forms in a boiler tube

Fig. 7. Galvanic corrosion has caused severe thinning on tube's stud side

Copper deposits seem to be the most important factor in producing tube failures. Figure 4 shows a typical tube rupture.

Effect of Copper Deposits

Copper deposits have been found in most high pressure units. Heavy, localized deposits may consist of as much as 70 per cent (by weight) of copper, in a hard matrix of iron oxide. The laminated nature of these deposits complicates removing them, and in the past, two or more cleaning treatment stages have been necessary.

In multiple-stage treatments, an alkaline oxidizing solution is used first to remove the copper. An acid soak then follows to remove iron oxides. Several such stage treatments have sometimes been necessary in order to remove all copper deposits. Complete cleaning is important because any residual deposits will act as nuclei for rapid deposit growth, thus overcoming some of the value of the cleaning treatment.

Single-Stage Copper Removal

Although acid will dissolve copper which is mingled intimately with magnetite, in the past copper has sometimes replated out of the cleaning solution onto boiler tubes. The new cleaning method includes a complexing agent which is added to the acid solvent. This agent prevents dissolved copper from replacing upon boiler tubes, thus keeping it in solution.

Effectiveness of the agent is shown in Fig. 5. The two beakers shown contain the same amount of copper salts in a 5 per cent hydrochloric acid solution. Beaker on the right also contains the special additive. The steel strip immersed in the acid without the additive (left) has become heavily plated with copper. The steel strip in the other beaker has been effectively protected from copper plating by the additive agent.

Using this additive has made possible single-stage treatments in which both iron oxide and copper deposits are removed simultaneously. Such treatments reduce the length of time required to clean boilers and provide better cleaning. Inspections following single-stage treatments have shown that the method is highly effective, and that no copper has remained in units so cleaned. Boilers inspected have ranged in size from relatively small units to some of the largest boilers in the United States. Records of boilers cleaned by this process show that tube failures have been sharply reduced.

Principal limitation of this single-stage cleaning method is that it cannot be successfully used where large copper deposits are present without iron deposits intermingled with them. When such conditions are found, conventional two-stage cleaning treatments should be used.

Case Histories

First boiler cleaned by this new method was a unit producing 375,000 lb per hr at 975 psi. The boiler was filled with an acid solution containing the special additive agent. Figure 8 is a graph showing the concentrations of iron and copper in the cleaning solution at one-hour intervals, beginning with zero, which represents metal concentrations at the time the boiler became completely filled. Copper concentration had reached a maximum by this time, and it remained constant through the following six hours. As this concentration was below the saturation point of the solution used, this indicates that the entire copper content of the boiler (about 100 lb) was removed during the filling process.

Iron concentration increased rapidly until it reached 0.43 per cent, three hours from the time the boiler was completely filled. Thereafter it rose only slightly, as the last traces of iron oxide scale were dissolved.

These curves are typical of results obtained during single-stage copper removal treatments. Each point on the curves represents the average of four separately analyzed samples, taken from different sampling stations in the unit. Sampling techniques are extremely important if accurate records of the cleaning solution's iron and copper contents are to be obtained.

This boiler was carefully inspected following the cleaning treatment, and no evidence of copper plating could be found. A few small flakes of copper were discovered in the small amount of debris remaining in the boiler.

Another boiler cleaned by this method had a past history of localized heavy deposits and tube failures. This unit is an 875,000-lb boiler which operates at 1500 psi. Because

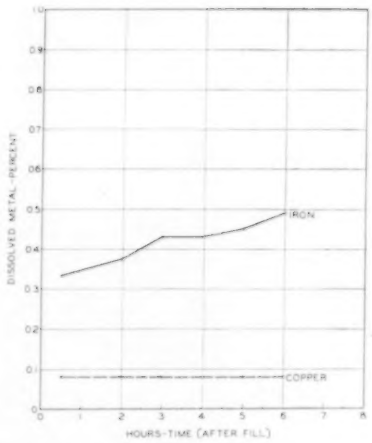

Fig. 8. Iron and copper in cleaning solution. Zero is time the solution filled boiler

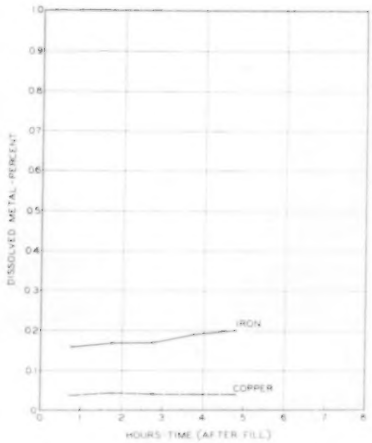

Fig. 9. Flatness of copper curve shows all copper was removed from boiler

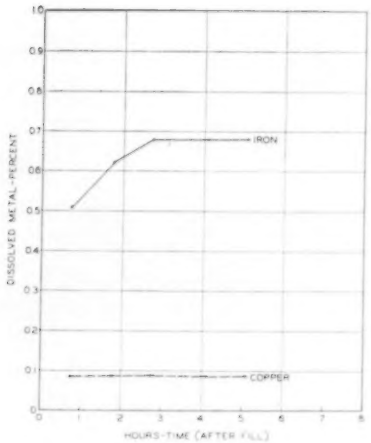

Fig. 10. Solution used in cleaning a 375,000 lb per hr boiler, at 975 psi

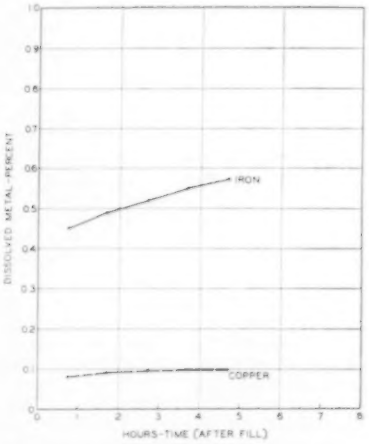

Fig. 11. Curves show boiler had small areas of very heavy copper deposits

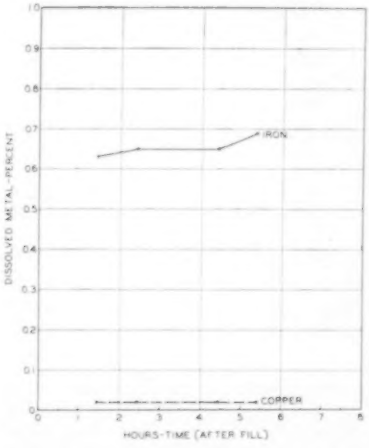

Fig. 12. Iron and copper contents during second stage of cleaning treatment

of the seriousness of past tube failure difficulties, a series of three cleaning treatments was planned. The first two treatments were conducted before the new single-stage method was developed. These treatments were three months apart, and the third, a single-stage copper removal treatment, followed six months later.

During the third treatment, 112 lb of copper and 740 lb of magnetic iron oxide were removed. Figure 9 is a graph showing iron and copper content of the solvent during this third treatment. In view of the fact that the solution used was not saturated, the flatness of the copper curve indicates that all copper was removed within two hours after the boiler was completely filled. No tube failures have been reported since this planned program was completed.

Figure 10 shows the iron and copper contents of the solution used in cleaning a 375,000-lb-per-hr boiler, which operated at 975 psi. This cleaning treatment removed 112 lb of copper and 1150 lb of iron. It can be seen that the iron concentration curve remained essentially flat after the third hour from the time the boiler was filled. This is also true of the copper curve, showing that the actual work of cleaning was done largely during the early part of the treatment. Most of the iron and copper was actually removed by the cleaning solution while the boiler was being filled.

A 400,000-lb-per-hr boiler operating at 900 psi had suffered heavy localized deposits and consequent tube failures for several years. Figure 11 shows an interesting fact about the cleaning of this boiler. Both the iron and copper curves slope upward throughout the reaction period instead of flattening out as such curves ordinarily do. Apparently small areas of extremely heavy deposits in this boiler required longer reaction time for removal than was necessary in boilers where deposits were less severe. A total of 137 lb of copper and 1100 lb of iron was removed from this boiler.

When copper deposits are unusually thick or when the copper and iron are not intermingled, the single-stage copper treatment cannot remove all copper deposits. In such cases, treatment with an ammoniacal oxidizing copper solvent should precede the normal single-stage treatment.

Use of Combination Treatments

The case of a 666,000-lb-per-hr boiler operating at 1325 psi illustrates the use of this technique. Analysis of deposit samples taken from the unit before the cleaning service showed about 30 per cent metallic copper content. Because this large amount of copper would have required an uneconomically large amount of the complexing agent used in single-stage cleaning treatments, a preliminary stage of ammoniacal copper solvent was used first. This treatment removed more than 600 lb of copper.

The boiler was then flushed with water and treated with the acid solution containing the copper complexing additive. This stage removed 35 lb of copper and more than 1600 lb of black iron oxide. Without the complexing agent, this copper would have replated from solution and remained in the boiler. Figure 12 shows the solvent's iron and copper contents during this second stage of the treatment. THE END

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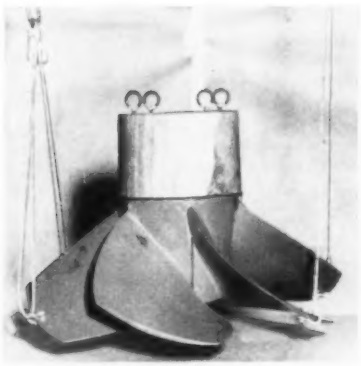
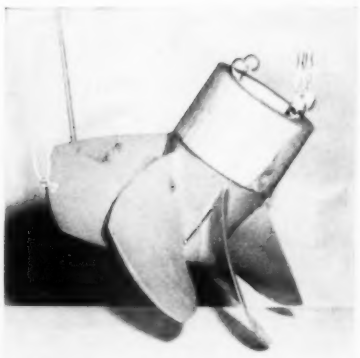


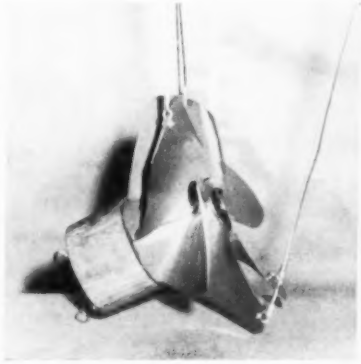
1 Runner with shaft removed. Attach double slings to hook of main hoist, single slings to the auxiliary hoist

2 Heavy lifting by main hoist of crane eases the runner onto wood blocks. Lift is always close to floor



3 Two single slings are now moved to eye-bolts in hub or crown of runner in readiness for operation 4

4 By raising on the main hoist and lowering on the auxiliary hoist, the runner is eased down on its side



5 Single cables are removed from hub, hanging runner is turned 180 deg, slings are attached to blades

6 Holding weight on main hoist, with some weight on floor, auxiliary hoist raises runner to upside down

Turn That Runner This Way

By LLOYD McWILLIAMS *

PROPELLER-TYPE runner weighing 45 tons is a cumbersome piece of machinery to sling, especially when it must be turned over to do welding on the under or discharge side of the blades. Slinging around the blades makes for sharp corners in the sling, thereby greatly reducing its rating. Also, there is danger of slippage, which may result in sudden, unnecessary stresses imposed on the various components.

The photographic sequence shown here illustrates a method of slinging on a large runner, which was worked out by a group of six men experienced in the slinging and moving of machinery. It all began as a result of a mishap which occurred while lifting a heavy turbine runner. The writer was asked to set up a panel to investigate the cause of the accident and to come forward with recommendations covering the more difficult lifts encountered in the hydroelectric field.

In studying the problem, one of the group suggested that we experiment with the small models of runners which, years ago, were used for testing purposes. With miniature slings we could rig up the slinging in various ways until the best possible method was determined.

The scale model shown in the photographs was the result. It is scaled 1 in. to the foot and has a diameter of 16 in. (Actual runner is 16 ft in diam.) The miniature slings were made from ⅛-in. aircraft control cable, 30 in. between the eyes. Four slings were made, since our group decided that four 1½-in. 6/19 slings should be used in making future lifts on the 45-ton runners, which are 30 ft long. A safety factor of not less than 6 is standard.

Lifting and turning of runners is not an everyday task, even in the hydro plant; in fact, in this particular plant, only three runners had been turned over in 30 years. Inquiries were sent to the manufacturers of large turbines.

From one manufacturer we learned that it is now customary to drill holes in the outer edges of the blades, on propeller-type runners, for the purpose of facilitating handling. On leaving the shop, bronze plugs are inserted in these holes; these can be removed fairly easily, should it be necessary to work on the runner in the field. These holes accommodate the inserting of eye-bolts or shackles of a size that matches the size and weight of the runner. With shackles in the outer edges of the runner blades, the slinging becomes a comparatively simple matter. THE END

* Maintenance Supervisor, Shawinigan Water and Power Co, Shawinigan Falls, Canada

RCA Trains for Power Maintenance

In RCA's big plant in Camden, N. J., maintenance in the power department is carried through on a preventive basis by a crew strongly trained at two levels of the work. Here's how the program operates

By JOHN S. COLE *

IN THESE TIMES of general increase in manufacturing costs, and decrease in income and profits, the power or utilities engineer is caught in the budget squeeze. One of the first reactions of top management, in this case, is to examine most critically the departmental maintenance costs, and to make drastic reductions in the money allocated for maintenance costs. At this time, a maintenance crew well trained for the job will pay off in helping to reduce these costs.

Training of a maintenance force falls naturally into two parts. First, new employees must be trained to take their places on the maintenance team, and second, all maintenance men must be continually trained in the use of new methods and in work on new equipment.

Training of new employees in maintenance calls for the recognition of the latent talents and skills of those people, and developing those talents and skills so they can be used to the fullest extent.

In our power department we classify men in two basic groups, power plant maintenance mechanics and power plant electricians. Each group has two ratings, according to the skill of the men.

We have found it to our advantage in hiring new employees to start all new men in the lower, or second class rating, and to train them on the job for future up-grading. By selective interviews and careful choice, vacancies in the lower rating can be filled from applicants who have the basic requirements and future potential for promotion to first class mechanics.

Actual training of a new employee starts with the preliminary interviews, before he is hired. All of the supervisory employees with whom he will work are given a chance to talk with him and come to a preliminary decision while they conduct him on a tour of the plant. The supervisors have a good opportunity to observe his air of interest in the surroundings, his alertness, and his reactions to the plant and working conditions as they are shown to him. They also have an opportunity to check on his knowledge as they talk with him.

If, after the preliminary interviews and a physical examination, an applicant appears fully satisfactory, and is hired, his training starts in earnest. He first is given an indoctrination course, conducted by Personnel.

In this course he is acquainted with the history of the company and its labor policies. He is told of the responsibility of the company to its employees, and the responsibility of the employee to the company. He is told of the various activities which are sponsored by the company, in which he can engage. He is also told of the various benefits which the company provides for him such as insurances, holidays, vacations and pension plans. He is told of company plans for sponsoring or paying for courses of instruction which will assist him in advancing toward promotions. He is shown that the opportunity for advancement is present, but that he must work and prepare himself so he can take advantage of the opportunity when it arrives.

In the plant, he again talks with the supervisors. He is made to feel welcome through introductions to his fellow workers. He is given a more thorough tour of the plant, and is again questioned about his aims and ambitions.

As a second class mechanic, he is assigned to work with and assist the various first class mechanics. The foreman has an opportunity to ob-

POWER PLANT MAINTENANCE MAN, FIRST CLASS

Duties

Installs, repairs, replaces and maintains power plant equipment and air conditioning and refrigerating equipment and accessories and operates air conditioning and refrigerating equipment and accessories: removes, installs, repairs, and maintains boilers and boiler components such as fire walls, tubes, burner equipment, ducts, flues, iron work and pressure, flow and altitude meters or gages using cement and compound, hand tools, mechanical drilling and cutting equipment and hoists; replaces or repairs pumps, compressors, condensers, evaporators, pulverizers, turbines, cranes and conveyor equipment using machinist's and pipefitter's tools; installs and repairs shelves, bins, lockers, shoring or framework using carpenter's tools; repairs and maintains rigging equipment such as rope and wire falls and tackle and yokes and hoisting equipment using hand spikes, marlin spikes, pliers and wrenches; sets up and operates compressors, condensers, evaporators, humidifying and dehydrating equipment and accessories using hoisting equipment, wrenches, pliers, screwdrivers, tube and pipe cutters, pipe-bending and forming tools, soldering equipment, hammers, chisels, spirit levels, and plumb lines, machinist tools, meters, gages and various special tools to install and maintain; works to equipment specifications, blueprints and schematic drawings; replenishes refrigerant when pressure and flow meters indicate necessary according to specifications, using special methods determined by type of refrigerant.

Qualifications

Educational experience shall include one year of high school or equivalent. Trades training in one of the following specialties: carpentry, pipefitting, plumbing, machine work or refrigeration. The ability to work on his specialty to supervisory instructions with little direct supervision, but works under direct supervision on other functions not his specialty.

It is understood that only those employees regularly assigned to machine work will be required to operate the lathe and milling machine.

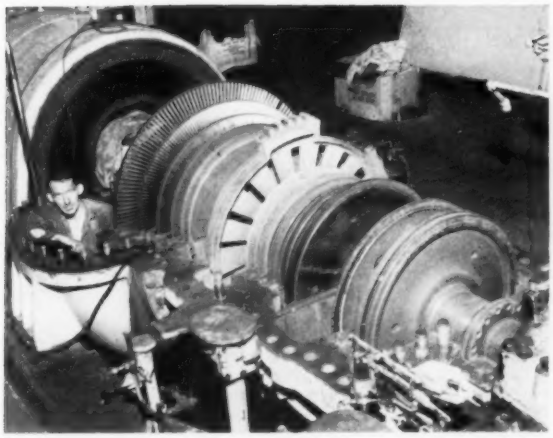
POWER PLANT MAINTENANCE MAN, SECOND CLASS

Duties

Assists Power Plant Maintenance Man, First Class, in the installation, repair, replacement and maintenance of power plant equipment working according to blueprints and verbal instructions: aids in replacing boiler walk, knocking down old walls with sledges and crowbars and replacing with bricks, mortar and cement using bricklayer's tools; installs bulk and board insulation using metal strapping and strapping tools, canvas, palm and needle, shovel and knife to secure in place; removes and replaces fire brick and boiler tubes using picks, chisels, hand sledges, crowbars, wrenches and miscellaneous tools and hoisting gear to remove, replace and secure material; erects and removes iron foundation or construction supports, platforms, and ladders, wooden scaffolding, shoring and framework, temporary or permanent equipment such as bins, lockers, and work benches, using ironworker's and carpenter's tools; fabricates replacement parts using hand- and power-operated metal and woodworking tools; installs new equipment in collaboration with Maintenance Man, First Class.

RCA classifies its power plant maintenance men in two basic groups, as shown here

* Superintendent of Power, RCA, Camden, N. J.



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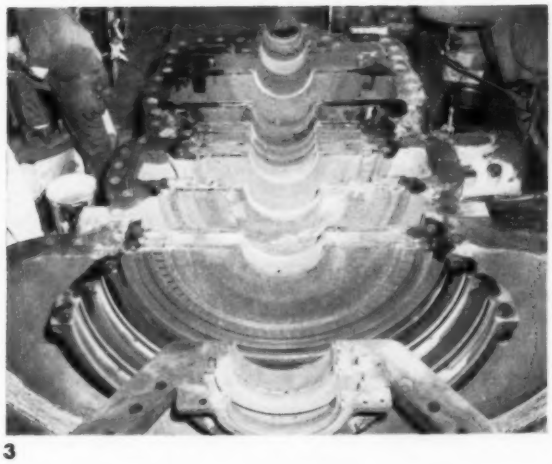

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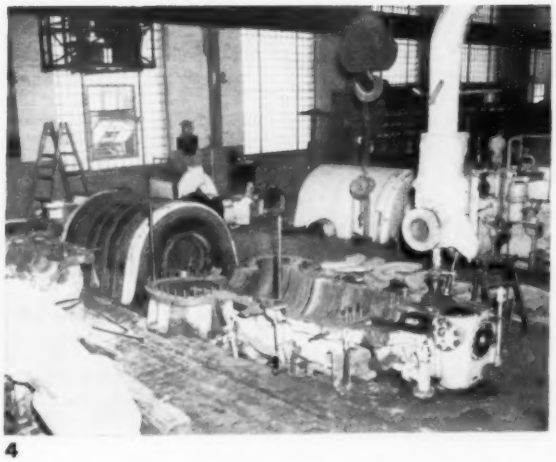


4

A NEAT JOB OF PREVENTIVE MAINTENANCE

Here a high-pressure turbine generator at RCA's Camden plant gets routine 5-year inspection. 1 — Rotor appears, in first stage of stripping process. 2 — Rotor is removed and buckets and wheels are cleaned by dust-blasting. 3 — Diaphragms are also removed and dust-blasted to clean. 4 — Unit completely stripped.

While work was proceeding on the turbine, stator windings were cleaned, ties and wedges were inspected and tightened as required. Windings were meggered out and painted. Field assembly was cleaned and meggered. Slip rings were cleaned and inspected. On reassembly, all worn governor valve and extraction gear parts were renewed. Unit was test run and returned to service.

Complete job was done in 800 man hours on a straight time basis by four mechanics and two electricians working under manufacturer's engineer.

serve his work habits, and to talk with the first class men with whom he works, to get their reactions to his knowledge and ability.

The new employee is encouraged by supervision to take advantage of courses relating to his employment, in the local high schools and vocational school. The company makes the taking of such courses attractive by offering tuition loan and tuition refund plans to all employees. The company also makes the tuition loan and refund plans available to employees who desire to take courses which are not offered at local schools but which are related to his work and are given by correspondence schools.

The job descriptions reproduced here show that each first class mechanic must have a basic trade, as well as general skills. As the new employee rotates between the first class mechanics, he can see which trade he wants to make his basic one. After he has picked his basic trade, as boilermaker, bricklayer, pipefitter, millwright, machinist or refrigeration mechanic, and after the foreman has talked with the mechanics in that desired trade to be sure that the man is picking the right spot, he is permanently assigned to assist mechanics in that basic trade.

He is then encouraged and guided in the selection of training courses which will enable him to back up his on-the-job practical training with the knowledge of theory which goes to make a good all-round mechanic.

Under this plan, he will, at the completion of two years' service, have had about 3000 hours of practical training in a basic, selected trade, and about 1000 hours of practical training in general power plant maintenance in all trades. In addition, he will have received about 300 hours in classroom study or home study in courses relating to his general and basic work. At this time, he will also have reached the top pay bracket of a second class mechanic.

During this time, the foreman has had ample opportunity to observe the man as to initiative, ability, punctuality, safe work habits, and to rate him on these factors. At this time, it can be decided whether to promote the man to a first class mechanic, or

to require further seasoning and instruction as a second class mechanic before such promotion can be made. In either event, the man involved is notified personally of the decision, and is given the reasons for making that decision.

The burden of preparing for advancement lies fully on the man himself, which fact is stressed from the first interview. The supervisory force is ready and willing to assist and encourage every employee in his efforts to advance and improve. It therefore becomes necessary for the selective interviewing prior to hiring to eliminate those who lack initiative, and who do not have the immediate desire to improve and advance themselves. We are not hiring immediate helpers, we are hiring future mechanics.

A well-trained, capable mechanic can carry on a job to completion with a minimum of supervision; therefore, any time spent by a foreman or other supervisor in training activities will tend to reduce the work load of that supervisor.

When a mechanic has been rated first class, a promotional pay increase is given to him. He has three additional merit steps in that pay bracket to reach the top rate of pay. These merit increases are given to him as he earns them, and on the recommendation of his immediate supervisor.

These merit increases help to maintain the study habits and the desire for increased knowledge and skill that have been implanted in the man during his preliminary training as a second class mechanic. To assist the man in reaching his top potential, each foreman has a library of manufacturers' instruction books, covering all equipment in the plant. Each mechanic assigned to a job is taught to use those books as his basic reference, and to follow the instructions contained in those books at all times.

Most of our maintenance is carried through on a preventive basis. Equipment is removed from service on a running time basis which has been established by our experience. Each item is dismantled completely, and all parts are inspected for wear or breakage. All worn or defective parts are replaced as required to restore the unit to normal condition. During this work, the manufacturer's instructions and drawings are followed implicitly to secure the necessary clearances and tolerances.

Major equipment, such as turbines, generators, and large air conditioning units, are serviced on a similar basis, but field engineers from the manufacturer are brought in to supervise such inspection and repair.

Field engineers are also brought in to supervise the installation and start-up of new major equipment. We have found that these men are always very capable and willing instructors. Therefore, we make it a point to have these men instruct our maintenance personnel in proper procedures and methods while they are in the plant.

Company benefits as to educational and training courses do not stop when a mechanic reaches his top rating. The company makes a general practice of promoting existing personnel, if qualified, to fill any vacancy which exists. Therefore, any man who wishes to prepare for further promotion is encouraged to carry on with his studies. Some men, under this plan, have completed high school work and have gone on to college. They have obtained the degrees which prepared them to win promotion to much better positions in the company. THE END

High-Temperature Piping Problems Solved With New Expansion Joint Design

CONTROL of high temperatures and pressures has always been a challenge to resourceful chemical and petroleum design engineers. A case in point is the unusual installation of 67 very large Badger expansion joints at the new Orange, Texas plant of the Firestone Tire and Rubber Company. At the plant, which produces 40,000 tons per year (10,000 lb per hr) of butadiene from butane via the Houdry catalytic dehydrogenation process, 23 of the joints are a whopping 72 in. in diameter (see Figs. 1 and 2).

But size was not the only design problem at the plant. Some of the joints had to withstand temperatures as high as 1100 F. Also, the joints had to compensate for complex movements. In many instances, the forces on the anchors and connected equipment were critical and it was necessary to use systems of hinged joints or tandem joints in order to minimize these forces.

Other joints, because of complex piping arrangements, had to take axial movement as well as lateral movement in two different directions. In the case of some of the pipelines to the towers, the question of forces due to wind loading, weight of pipe and other factors, resulted in unique designs of the hinges.

The process called for hydrocarbon lines with a pressure range from vacuum to two pounds absolute and temperatures from 1000 F to 1100 F. Air lines operate at 12-lb pressure, and the same temperature ranges. Hydrocarbon lines vary in diameter from 30 in. to 48 in. Air lines are 54 in. and 72 in.

For the installation, Badger Mfg. Co used its Series 50 (low pressure) joints. These incorporate a curvilinear corrugation design which results in more uniform movement per corrugation. The design is based on a careful correlation between shape, height and pitch of the corrugations. Weight is about half that of conventional joints, and flexibility is increased.

Because of the severity of temperatures, the bellows of all the Firestone joints were fabricated from stainless steel. However, the welding ends are of stainless only on the high temperature hydrocarbon lines. On the air lines, where temperatures are lower, carbon steel welding nipples are used.

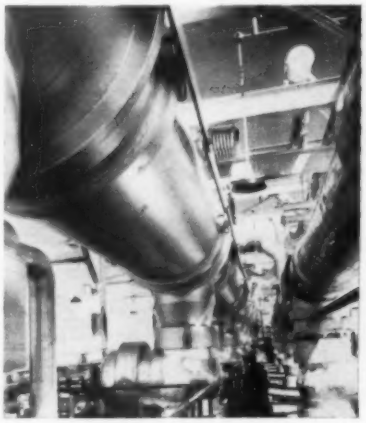


Fig. 1. Hot air to reactors (left), hot hydrocarbons to reactors (right)

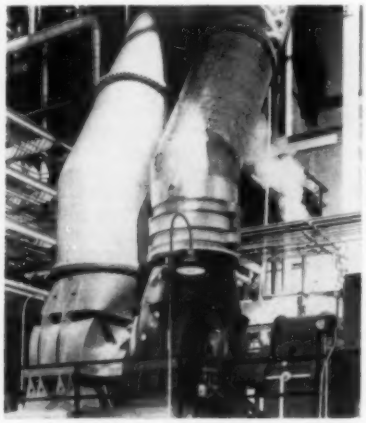
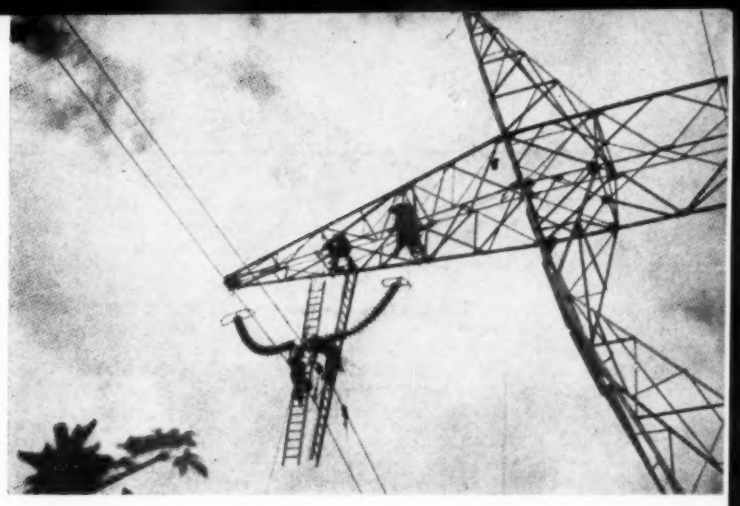


Fig. 2. Air blower with joints in discharge pipe. Joints have 72-in. diam



View of workmen re-assembling each pair of 220-kv lines into single circuit for 380 kv on Plessis-Gassot to Genisiat line of French system

CIGRE Reports European Power Systems Will Be Expanded at 380 kv

At 17th CIGRE meeting in Paris, June 4 to 14, 1958, world's electrical engineers report on expanding high-voltage systems and interconnections, larger generating units, progress in control and protection, cables, insulation, transformers and circuit breakers

By CHESTER R. EARLE
Editor, POWER ENGINEERING

AMID THE NUMEROUS attractions and distractions of the magnificent city of Paris, France in the springtime, over 1700 power engineers gathered for serious technical discussions at the 17th CIGRE meeting from June 4 to June 14, 1958. Those engineers came from every country in the world to contribute their knowledge of high-tension electric systems to their colleagues.

Meetings of CIGRE are held every two years.* The organization has headquarters in Paris. It is an international organization and the word CIGRE (pronounced see-gray) is formed from the initials of Conference Internationale des Grand Reseaux Electriques; or, in English, International Conference on Large Electric Systems. It operates with the support and assistance of all the large international electro-technical organizations. Any electrical engineer, any industrial or scientific society, any organization devoting its activities to high-tension electrical systems, may become a member.

Organization of Meetings: Technical sessions are devoted to discussion of points covered in the technical papers prepared for the Conference, but the papers themselves are not read. Instead, the papers are preprinted in both English and French, the two official conference languages, and a complete set of these papers is sent to each registrant well before the conference opens. Then he has time to study them and prepare comments on various points brought out.

Each session has a chairman, a secretary and a special reporter. The latter studies all the papers of his group, summarizes them, and selects important points for discussion. The chairman then calls on various individuals, who have indicated their desire to do so, to discuss them in a 5-minute talk. Discussions are delivered either in French or English, and an interpreter immediately re-presents the discussion in the alternate language.

In addition, each member is provided with a small transistor radio receiver and headset, by means of which he can listen to the simultaneous interpretation as it is presented. A small radio transmitter broadcasts the discussion and interpretation. Another useful device, in charge of a platform chief, is an illuminated panel on which, with large detachable letters, he posts each discusser's name and a code letter indicating his country.

Incidentally, this "reporter" method of conducting a technical session has been tried by the Lubrication Division of ASME in the United States and has aroused considerable interest as a way of stimulating discussion in meetings.

Behind all the discussion of technical details lie two very important factors: the fact that the demand for electricity is increasing in every country (see POWER ENGINEERING January 1958) and the fact that more high-voltage, high-capacity power networks and interconnections must be provided for delivering power wherever it is needed for both industrial and domestic use. Electric power builds up industrial productive capacity and raises human living standards everywhere — a truism.

In existing power systems, means must be found, primarily by raising voltages, to raise the capacity of existing transmission lines. In some countries, engineers foresee direct-current transmission as an aid in doing this. In building new systems, power engineers are looking ahead and starting with 380-kv networks, and talking about the possibility of 700 kv systems or even higher and of greater capacity. That is the reason for much discussion, among CIGRE engineers, of line losses, use of capacitors, cable design, details of circuit breakers, disconnects, transformers and every other factor involved. Many of the components required in the systems 10 years from now must be installed now, and, to determine what they will do, elaborate test laboratories and facilities have been set up in many countries.

In short, the electrical engineers of the world are looking ahead and are coöperating with each other, by interconnecting their electrical systems and by exchanging technical information on a world-wide basis through CIGRE, in a way that should carry over into every social, economic and political phase of life.

*R. H. Morris editorial director, and A. W. Kramer, then editor of POWER ENGINEERING, attended the CIGRE meeting in 1956 and reported its highlights in the August, 1956 issue.

Editor's note: All illustrations from original papers.

IN HIS REPORT on coupling of alternators by the autosynchronization method, C. Penescu of Rumania described a method of calculation to check the time taken for alternators to come into synchronism — a matter of a few seconds.

There was considerable discussion of generator cooling procedures, especially of water-cooled stators. W. N. Kilner of England showed how, after considerable testing, his company settled on pure water for inner-cooling of stator windings. They rejected hydrogen because of constructional difficulties and oil because of high pumping power and lower specific heat. Water is used at 40 C in parallel flow; for larger contemplated 200-mw units, the water cooling will be in a circuit entering a hydrogen-cooled casing. Main generator terminals will also be water cooled, it was explained.

Hydrogen cooling of generators was thoroughly covered, especially by Dureault, Letrilliart and Valentin of France, with many comments on the use of hydrogen cooling in USA, influence of power factor on dimensioning of rotors and stators and distribution of temperatures.

With the new methods of cooling, said Mullner of Germany, and Wiedemann of Switzerland, size of alternators can be increased to 350-mw with reliability, with decreased rotor diameter for a given output.

Influence of an increase in exciter response, said Hamdi-Sepen of Turkey, is rather small in the first 0.2 sec, especially if the machine is connected to an infinite bus through a long transmission line and this is more than the fault-clearing time generally permitted in transmission systems.

Excitation of synchronous machines by mercury arc rectifiers with grid control, magnetic amplifiers, or transistor circuits, was discussed by Frey and Noser of Switzerland Rectifiers are more expensive but are as reliable as other methods. Electromechanical regulators, properly designed and built, are adequate for most control problems and are simple, reliable and economical.

Frittum and Mosbeck of Austria described equipment for coupling and regulating a station of two 20-mw units at which interconnection is made between a normal 3-phase 50-cycle system and a single-phase system at 16⅔ cycles, the latter frequency being necessary for Austrian electric railway systems. The system shown in Fig 2, and described in detail in the paper, has proved economical and stable.

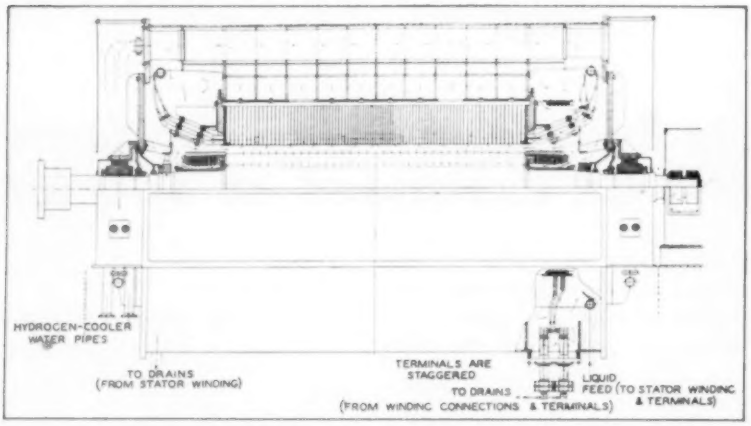

HYDROGEN-COOLER WATER PIPES
TO DRAINS (FROM STATOR WINDING)
TERMINALS ARE STAGGERED
TO DRAINS (FROM WINDING CONNECTIONS & TERMINALS)
LIQUID FEED (TO STATOR WINDING & TERMINALS)

Fig. 1. Cross-section of 200,000-kw turbine generator; hydrogen cooled and with water-cooled stator winding as described in session on generators

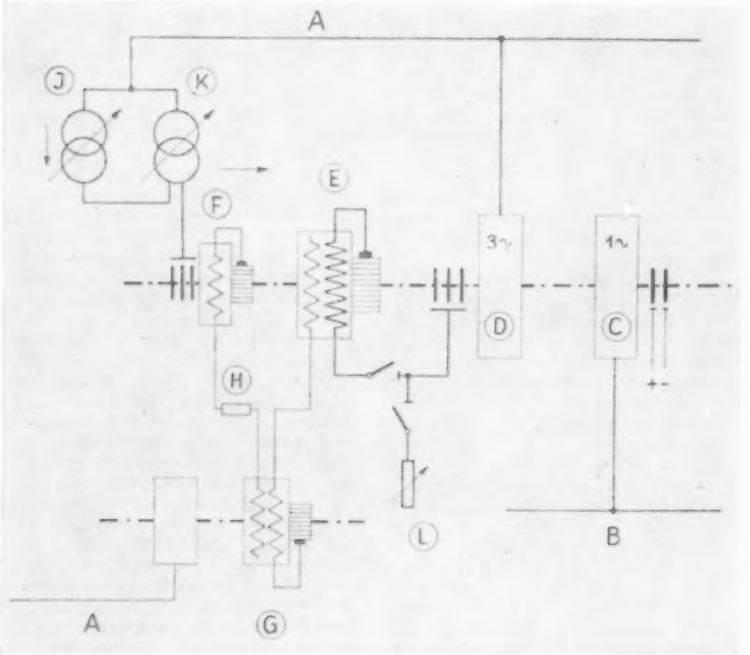


Fig. 2. Simplified diagram of a converter set for connecting a 50-cycle system with a 16⅔ cycle system supplying power for Austrian electric railway systems

A-3-phase 50-cycle system; B-single phase 16⅔ cycle system; C-asynchronous machine; D-synchronous machine; E- Scherbius machine; L- Liquid starting resistance; G- Exciter with resistance H in series with its excitation circuit; F- Frequency changer; J- Double induction regulator for effective output; K- Double induction regulator for reactive

Transformers: Primary trend in transformers, as pointed out by Wentz of United States, is toward larger kva and kv ratings, associated with the continual growth of power systems and the need for economy. Some of the means by which larger and more economical transformers are produced:

1. Continual improvement of magnetic material and more widespread use of 3-phase cores.
2. Reduction of insulation required.
3. More effective cooling, by use of forced oil cooling.
4. Better winding arrangements.
5. Use of newly-perfected methods for exact calculation of impulse voltage at any point in the winding.
6. Wider use of autotransformers.
7. A new heavy-duty car for transporting transformers designed from ideas received from Siemens-Schuckert.

Fault detection is commonly being

accomplished by rate-of-rise-of-pressure relay operating in the gas space above the oil.

Bushing dimensions have been standardized for 23 kv through 196 kv, permitting more interchangeability between manufacturers' bushings and reducing spare parts.

Meador of the United States covered transformer oil testing, effect of oil preservation, corona testing and phase to phase insulation. He described a new type of oil preservation equipment, Fig. 3, designed to overcome effect of oil bubbles, caused by pumping, that degrade oil's electrical strength from 20 to 60 per cent. The device overcomes other disadvantages of the conservator.

Casson and Harper of Great Britain reported on the various winding arrangements and construction of 275-kv transformers required for the British 275-kv grid system. Physical transporting of large transformers is an important problem. It was treated as one phase of a special study report by Langlois-Berthelot of France. Rail and road transport were discussed. The former may require depressed bottom cars, or else the beam tank on which the tank of the transformer itself is used between two bogies. He also discussed transport of dismantled transformers, use of air or CO_2 instead of oil during shipment, capacities of lifting gear and the like. Large power transformers are the US 380-mva units, also some 450-mva units in France, but other countries are producing units of 150 through 300-mva. Auto-transformers of 660-mva are being produced in Germany.

On-load tap-changing in transformers, according to Nolen of the Netherlands, seems to be employed on a relatively more general scale

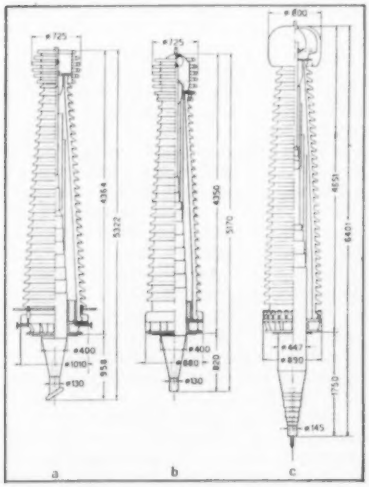


Fig. 4. New transformer bushings for 380-v systems. a, for a Swedish station, inclination 55 deg to vertical; b, for the French system, inclination 20 deg to vertical; c, for the German system, standardized, vertical mounting

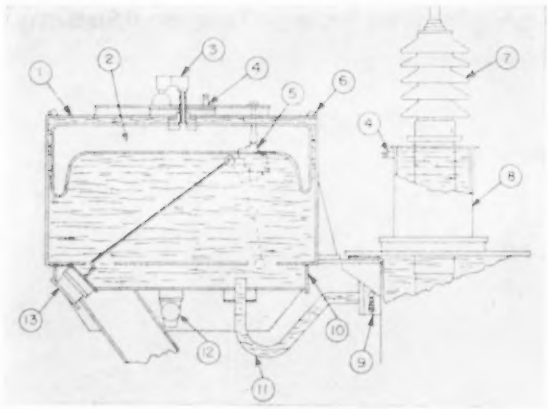


Fig. 3. G-E's Atmoseal oil preservation system showing parts

1, oil reservoir; 2, air cell; 3, air cell ventilating breather; 4, vent valves; 5, automatic pressure-vacuum relief valve; 6, lifting lug; 7, transformer bushing; 8, bushing adapter; 9, shut-off valve; 10, sump chamber; 11, thermal seal connection pipe; 12, globe valve; 13, liquid level gage with low-level alarm contacts. This device is a new development.

than in America. In Europe, by far the greater proportion of big new transformers are equipped with on-load tap changing; in America it is less than half. He described electrical tap changing in detail.

Recent forms of 380-kv transformer bushings, Fig. 4, were described by Kappeler of Switzerland. He traced their development and gave details of insulation, stresses, and the like, and said the results show there is no difficulty in making bushings with dry insulation for a nominal voltage of 700-kv and for currents over 1000 amp.

Circuit Breakers: Because of the development of extra high-voltage circuit breakers, said Chernyshev of USSR, necessity has arisen for setting up a test installation for determining the breaking capacity of the circuit breaker. Obviously, it is out of the question to erect a station with short-circuit power equal to the required breaking capacities, hence indirect methods must be used. He described synthetic circuits and methods of testing separate elements. The synthetic circuit is shown in Fig. 5. As a result of tests, a series of air-blast circuit breakers has been developed for voltages from 110-kv to 400-v and capacities up to 6000-mva and 15,000-mva. In operation on a network, he reported, not a single case of failure to interrupt the short circuit power has been recorded.

From the Lachmatt substation in Switzerland, the Aaretessin Electricity Co. Ltd. feeds electrical energy to several large consumers. Distribution is at 50-kv and the incoming power at 150-kv comes 100 to 130 miles from stations in the Alps, so inductive power is an important factor. Consequently 15.75 mvar capacitor banks, Fig. 6, were installed to discharge the transmission lines of inductive current. As a result, losses were greatly decreased, but it was necessary for the banks to be interrupted on low-load days. For safety, the breaker interruptions had to be measured. Schar and Baltensperger of Switzerland reported the results of these tests in paper No. 138.

Kinghorn, Barnes and Hauspurg of USA reported experiences with rapid reclosing on transmission lines of the 345-kv network in the USA. This system is in an area of high lightning incidence. Circuit breakers having a tripping time in the range from 5 to 8 cycles and a dead time of 10 to 13 cycles are used for high-speed reclosing. During two years of service, a total of 152 operations have been controlled and the number of successful reclosures, for the different grids, amounts to 94 to 100 per cent. (See table, page 12)

Amer and Young of Great Britain presented data on an arc control device for circuit breakers called the turbulator, designed to extinguish the arc. Latest type of this device is shown in Fig. 7. The arc is drawn in front of the lateral vents so that the oil and gas leaving the turbulator must work on the arc to extinguish it. Oil is injected into the turbulator during the opening stroke to assist the extinguishing action at low currents. The later type has oil entrapped in pockets at the rear, so that any tendency of the arc to move

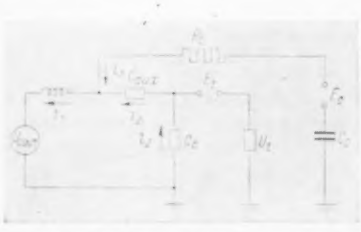


Fig. 5. System for testing circuit breakers with arc duration of several half periods (second variant)

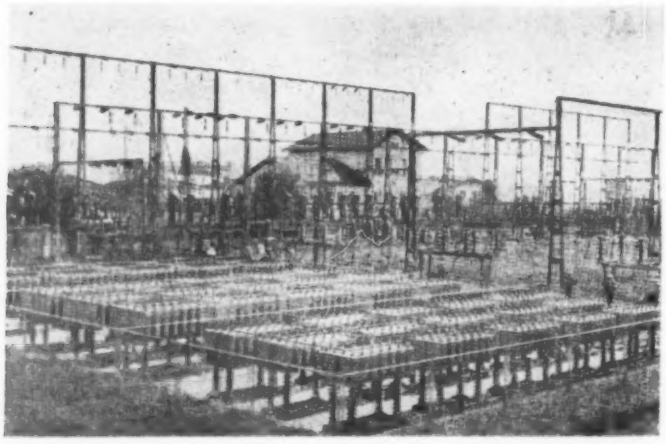


Fig. 6. Part of the Lachmatt substation, showing the capacitor bank

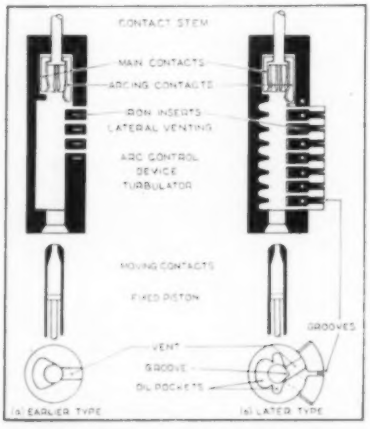


Fig. 7. Schematic sections of two types of turbulators, described in the text

from the position in which it is drawn is counteracted by increased generation of gas from the trapped oil. Also, design of vents and channels outside the turbulator provides maximum cooling, minimizes danger of flash-over.

Substations: Much interest was aroused by the various papers on substations. Droskin of USSR reported on new designs for outdoor 110, 220 and 400-kv substations in the USSR. Bus bars of the stations are of steel tubing. Earlier designs used the classical rotating type or pantograph type disconnect switches. Latest designs use a new cantilever type disconnect.

Designs for 400-kv outdoor substations provide either double main bus with two circuit breakers per circuit or double main bus with two breakers for the line circuits and direct connection between bus and transformers by means of a disconnecting switch. When there are four circuits, a ring bus is used. For large stations, a single breaker per circuit with a bypass bus and bypass circuit breaker permits any one breaker to be taken out of service for overhaul.

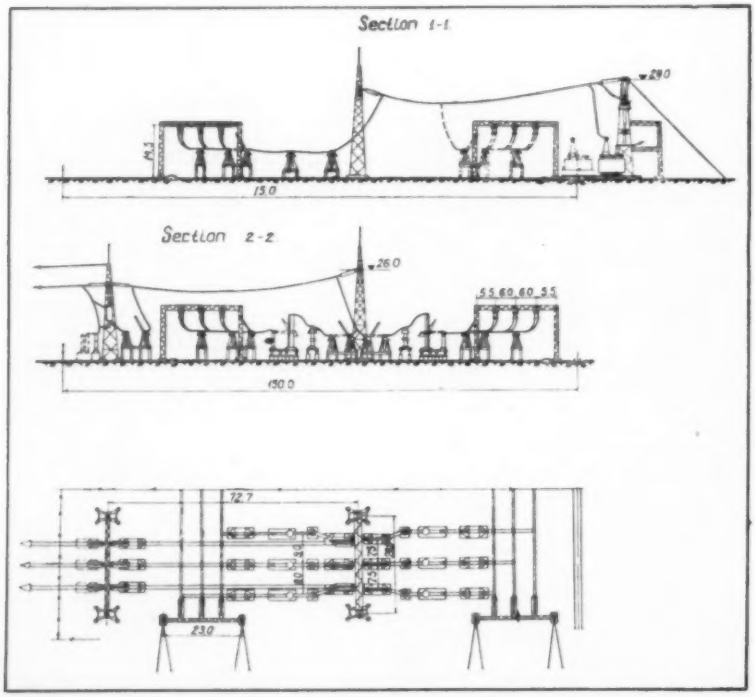


Fig. 8. Design of outdoor 400-kv substation with ring bus arrangement and disconnecting switch on the line side, as designed for some European stations

Other members discussed use of tubing for bus bars in substations, both outdoor and bunker types, the latter used in Germany. In some cases 110-kv cable was used for bus bars. Pantograph disconnects are sometimes used.

Gross of USA reviewed the use of cantilever-type disconnects in USA and asked about the cost of the pantograph disconnects as compared with the cantilever. The former, it was said, are more expensive, but definite costs were not given.

Cable buses were described by Oberdorfer of Austria. To meet high-voltage needs, it is planned to use single-phase oil pressure cables designed for no maintenance, no aging, and held under tension during automatically signaled disturbances. For branch sleeves, high standards of construction have yet to be found, but use of plastics may help. For economy and space saving, the disconnector insulators should also act as terminals for the bus bar cables, requiring redesign of the disconnect. The author says the pantograph type disconnect is particularly suitable for this purpose.

Substation design is influenced materially by location, whether in crowded areas, or underground, or outdoor, or enclosed, or with architecture to match its surroundings, and those factors were all discussed.

Just as increasing load affects installation of generators and of new connections, the load determines what supply system is placed between generators and consumers.

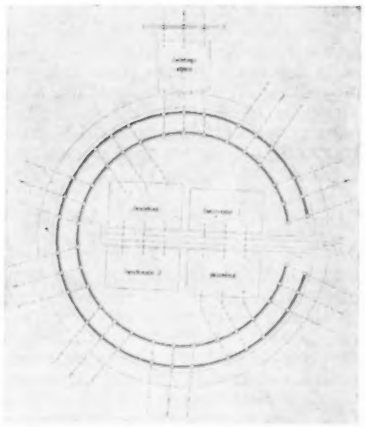


Fig. 9. Substation design with ring bus bar, designed for German stations. (Freileitungs-abgang means branch lines; Geröteblock means apparatus block; Transformateur is transformer)

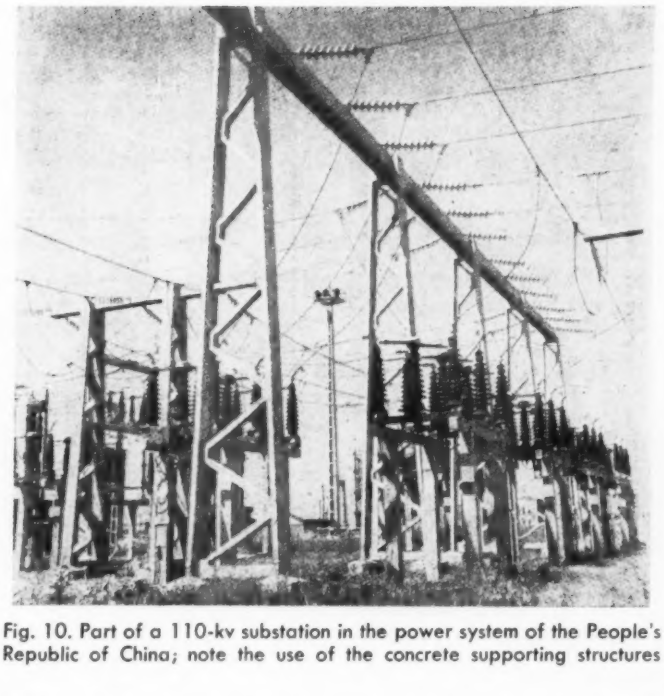


Fig. 10. Part of a 110-kv substation in the power system of the People's Republic of China; note the use of the concrete supporting structures

Mean of Belgium discussed supply systems in some detail, pointing out that it is one of the rare technical cases where the solution that provides the best service is also the most economical.

Analyzing the radial and grid systems for reducing 150-kv to 70, 36, 15 and 5-kv, the author concludes that the grid system has most advantages: increased reliability, increased transmitting capacity, ability to handle local overloads, better voltage regulation, lower first cost and other factors.

In large built-up areas in Paris and Lyons, said Dejou, Morisseau and Sallard, most important development is the introduction of very high voltages into the center of the cities and sometimes elimination of intermediate sub-transmission systems. This involves not only space problems but also substation design. The problems are: cooling of the transformers; reduction of the noise level of the transformers to the level suitable for the area; handling of the transformers and other equipment; protection against fire; noise of the cooling plant if oil pumps are used (water cooling is quiet). Size of the station, ventilation and insulation level to suit buildings where installed are also important factors. Similar data on Italian substation practice were given by Brambilla.

As part of the first 5-year plan of the People's Republic of China, technical data were given by Mao-Chun and Da-Hau on use of reinforced concrete structures for substations and supporting towers (Fig. 10). Indoor type switchgear for a typical substation cost 278,120 yuan, while outdoor gear cost 283,762 yuan.

For control of substations and other equipment, prefabrication and standardization of control and supervisory installations have been adopted by Electricité de France as described by Sallard, Mery and Verneau. The practice here resembles that of USA.

Remote control of water power stations and substations in Sweden, said Geijer, Nordstrom and Berginan, reduces labor considerably. Cost reduction compared to cost for saving on personnel is about 50 per cent a year. It is, of course, a question how far one should go in reducing personnel. Techniques for telemetering are well known, have been used for

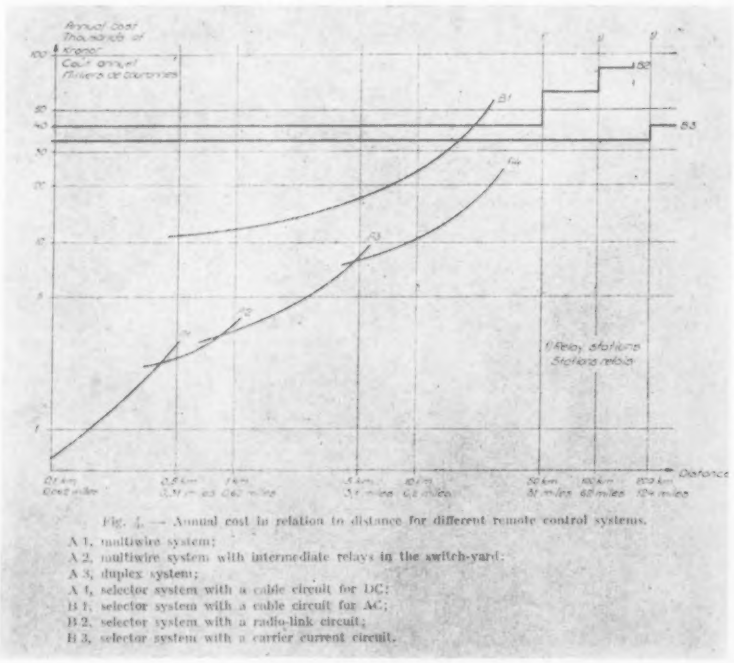


Fig. 4. — Annual cost in relation to distance for different remote control systems.
A 1, multiwire system;
A 2, multiwire system with intermediate relays in the switch-yard;
A 3, duplex system;
A 4, selector system with a cable circuit for DC;
B 1, selector system with a cable circuit for AC;
B 2, selector system with a radio-link circuit;
B 3, selector system with a carrier current circuit.

Fig. 11. Annual cost of different remote control systems in relation to distance. A1, multiwire system; A2, multiwire system with intermediate relays in the switch-yard; A3, duplex system; A4, selector system with d-c cable circuit; B1, selector system with cable for a-c; B2 selector system with radio link circuit; B3 selector system with carrier current circuit. This system is used in Swedish networks

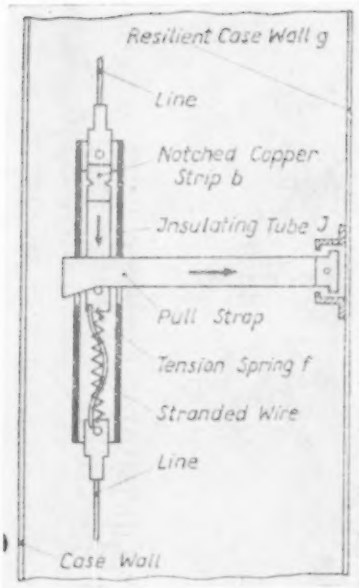


Fig. 12. German circuit breaker for use with medium voltage power capacitors

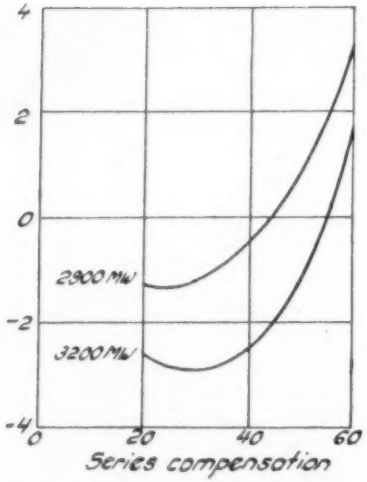


Fig. 13. Influence of series capacitors on the Swedish high-voltage transmission system. Vertical scale shows comparative transmission costs in millions of Swedish croner per year (see text)

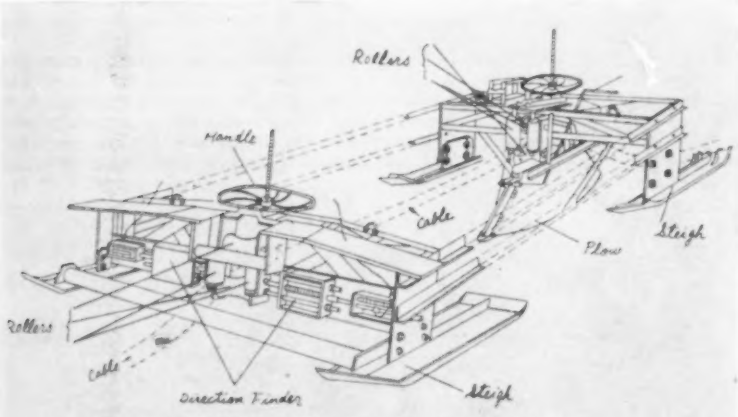
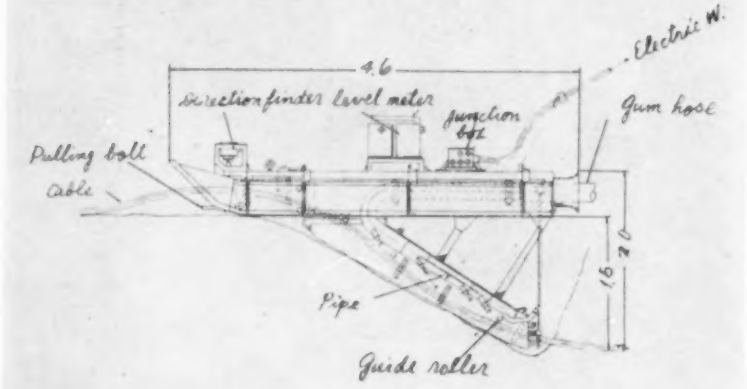


Fig. 5. — Plow-type burying machine.



Water jet type cable burying machine.

Fig. 14. For burying cable in sea bed between islands, Japanese power system has used these two types of cable-burying machines, as explained in the text

years in USA. The public telephone system is *not* used, but well-balanced four-wire cables with phantom circuits are used. Radio links are employed and in one small station, television is used, remotely controlled over a radio circuit, the TV picture transmitted over another link. Costs are as shown in Fig. 11.

Capacitors: Because of the trend to high-voltage transmission in all systems, the CIGRE members were much concerned with the problems of reactive power. For the first time in these meetings a group of papers on capacitors was presented. Development of larger energy sources, both fuel and water power, and transmission of the generated power over long distances, create reactive power problems. The reactive current should not be transmitted over long distances, because this produces high voltage drops. Accordingly, said Lehmhaus, on behalf of Study Committee No. 18, the power factor is corrected either by synchronous condensers or by capacitors.

Today the trend is toward the use of capacitors (static condensers) distributed in small banks over the network. Of course, in the USA and in France, synchronous condensers are still used in many cases. (In one installation in France, gas turbines are used to start them.) But in the newer electric networks, the trend, according to Lehmhaus and Roser, is toward the capacitor. In many countries, where at present there is now only limited compensation of reactive power with shunt capacitors, they will be installed on a larger scale within a few years.

There was much discussion of the relative uses and advantages of shunt capacitors and series capacitors. Up to now, series capacitors for high voltage have been installed only on a few important lines, as in the USA and in Sweden. They are usually employed to increase capacity of existing lines, regulate voltage and reduce surges. An American proposal by W. A. Morgan to install series capacitors at terminals of transformers, generators and motors on certain applications, aroused much interest. Also discussed was their effect on system stability. On the whole, the uses of capacitors were pretty well understood and approved. At the 1956 CIGRE meeting, data were given on the first three Swedish 380-kv series capacitors, each rated at 100-mvar, and a fourth of 160-mvar has since been built. In the USA, a series capacitor of about 100-mvar is being installed on the Grand Coulee 300-kv, 235-mile line.

Existing protective devices for series capacitors (short circuit protection, by-pass gaps and the like) still need much development, it was stated. It would be desirable to render unnecessary the external protective devices by increasing the internal safety factors. Certain designs can be made self-healing.

Qualities of paper used in capacitors were discussed. Pierson of Belgium advocated a porous paper of low density and lower dielectric losses as being better than dense papers. Elsner of Switzerland submitted a report on impregnants of capacitors. While formerly oil was used, later developments have led to the use of synthetics (Askarels, etc.) as well as mineral oils. American and later European practice has changed from the use of pentachlor-diphenyl to use of tetra or trichlor-diphenyl.

Walker and Coursey of Great Britain discussed protection of shunt capacitors with fuses, switchgear and discharge resistors. Practice here is not uniform. Bornitz, Hoffman and Leiner of Germany explained uses of filter circuits with capacitors and there were papers on corona losses, circuit breakers and other problems in the use of capacitors.

Construction, Insulation, Maintenance of Overhead and Underground Lines

CABLE for both overhead and underground lines was a subject of much interest to the members. Submarine cable for both a-c and d-c installations, with emphasis on the latter, was described by Mollerhoj of Denmark and Sutton and Morgan of Great Britain. After reviewing the requirements for submarine use, they explained the construction of a 2-core flat cable. A cable of this type would be suitable for the cross-channel 160-mw d-c cable link between England and France.

Analysis of the power that can be transmitted at 400-kv with low-pressure and high-pressure oil-filled cables, having the same copper section, has shown that the low-pressure oil-filled cable of conventional type is most suitable for transmission of very large powers. An experimental cable of this type having a copper section of 800 sq mm, and its related accessories, was described by Priaroggia, Morello and Palandri of Italy.

In the winter of 1956-1957, Oslo Power Supply Company started operating a 300-kv underground cable system between three transformer stations; total length of the line was about 12 kilometers; capacity 200-mw. As explained by Bodtker and Johnsen of Norway, the cables were laid in a trench, separated by cement asbestos plates for protection from short-circuit arcs, supported on a layer of sand, with a sand layer over them, then a concrete slab covered with fill. The cables pass under two suburban railways in 6-in concrete pipes, but vibration is negligible. They also cross a bridge, where they are supported by cleats hanging on spiral springs. Here they are laid in a horizontal wave form and the construction allows for bridge expansion.

Fig. 15. To supply power from the hydro plants of Yugoslavia to Southern Italy, supplementing an overhead line around the sea, this d-c high-voltage submarine cable is planned to connect Ragusa and Foggia across Adriatic sea; cable for 250 kv, area of 300 sq mm design

Japan, said Ikeda, has installed many submarine cables to transmit power between its various islands. Many technical difficulties were caused by such factors as bad sea beds, hard tidal flows, deep seas, bad weather. But these problems have been gradually solved.

One interesting feature is that in a 20-kv butyl rubber insulated cable laid in Japan in 1956, a radioactive isotope was used to help locate the cable in the future. Another feature is the method used for burying the cables. After determining the nature of the sea bed, by a supersonic depth meter, one of two burying machines, Fig. 14, is used. The plow type machine carries the cable on rollers and is pulled ahead by a ship; the plows dig a trench of V-shape and drop the cable into it. In the water-jet type machine, the working ship delivers high-pressure water to the nozzle, making a hole in the sea bed. The rear of the machine goes down under the sea bed until supported by the sleighs, dredging the ditch and depositing the cable in it.

Data on tests of 220-kv and 400-kv d-c cable in the USSR were given by Gorodetsky. These cables are still under development. For an 800-kv transmission line, both solid type cable and oil-filled pipe-type cable are being investigated. Design of the sealing ends was shown, also the design of joints.

Design of a submarine cable across the Adriatic Sea, to transmit power from Yugoslavia to Southern Italy was described by Visentini, Asta and Trimani. At present, power is transmitted by overhead lines around the head of the Adriatic to connect with the Italian system at Gorizia; but a d-c submarine cable of 300 sq mm cross-section, at 250-kv, has been designed to cross the Adriatic, a distance of about 128,000 kilometers as shown in Fig. 15.

Ingledow, Hollingsworth and Williams of Great Britain reviewed the installation of the 138-kv 120-mw submarine gas-filled cables that now link Vancouver Island to the mainland of British Columbia. The method of cable laying and control were described and this method will be used again for two additional cables.

Hansson of Sweden described a new design of cable for future 425-kv lines, designed for high dielectric strength, low losses and better cooling, Fig. 16. An oil pump forces oil longitudinally through the hollow conductor at about 20 atmospheres (approximately 295 psi). The oil also flows radially through the insulation in outer channels under lead. The oil returns through outer channels and return pipe line to the vacuum storage vessel where the oil is degasified.

There were several papers describing design and experimental work on cable insulation with synthetic high polymer materials and oil, with plastic insulation for both a-c and d-c cables, with polyethylene insulations and various impregnated paper insulations, all for both overhead and submarine work.

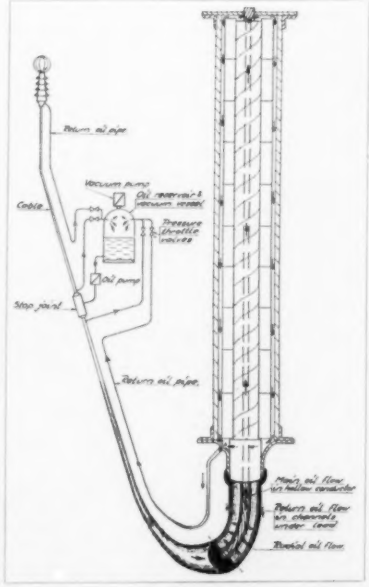


Fig. 16. Diagram of oil flow in a new type of cable with continuous oil flow

SESSIONS DEALING with system stability and load and frequency control stimulated good discussion. Of special interest was the description of the parallel operation of the German and French electric systems with automatic control. The French systems, the peak power of which is nearly 10,000 mw, and the German systems, the peak power of which is nearly 15,000 mw, were interconnected during the winters of the past two years by the single 225-kv line from Saint Arold to Treves.

In practice, during parallel operation, the frequency was maintained within a band of 50 ± 0.015 cycles, the deviations exceptionally reaching 0.1 cycle. The method of operation, said Brutzel, Germany and Chevallier, France, was satisfactory, does not require a central control point, but requires only a simple agreement between the control rooms of the two systems. The amounts of power involved were of the order of 70 mw.

Computer Applications: Use of a graphic analyzer based on the use of short-circuit currents for the study of high-voltage systems was described by Dimo of Rumania. Digital computer applications in power system analysis were covered by Brown and Tinney of USA. These applications and the computing equipment are advancing so rapidly that any conclusions based on the present situation can only be tentative.

In the Belgian system, said Denis of that country, a system of load frequency control has been used to control a combination of 10 networks fed mostly by steam power stations. The scheme is based on transmitting from a single control point a single variable called the "level," which determines the control power demanded of each generating unit. On tests, this maintained the frequency within about 0.05 cycles. The control circuits are shown in Fig. 17.

Exhaustive analysis of tests made to determine the regulating power and the static stability of the interconnected networks of western Europe was presented by the Union for the Coördination of Production and Transmission of Electricity (UCPTE). This showed results of tripping tests for the whole interconnected network carrying about 27,000-mw.

Lightning and Surges: Ellis and Link, of Ontario, reported the development of a lightning stroke counter for transmission systems. The instrument records electromagnetic impulses and light flashes generated by lightning, counts the number of individual discharges in multiple strokes to earth, also measures the time intervals between successive components as well as the total duration of such strokes. Records of 3012 strokes were evaluated.

High-speed automatic reclosing, in the case of lightning strokes on transmission lines, is recommended by Burgsdorf, USSR, as the most reliable method. Good grounding on 110-kv and 220-kv lines on metal towers is recommended in regions of frequent thunderstorms, also grounding of the supports. Insulation properties of wood-pole lines obviate need for grounding, said the author, for it would increase the cost by 20 per cent.

Overvoltages in direct lightning strokes up to 8000-kv are measured in Sweden, said Lundholm. In Czechoslovakia, said Homa, maximum amplitude of lightning currents was 244 ka. Switching overvoltages are of low amplitude, so lightning arresters can be expected to operate on 3 to 10 per cent of the overvoltages produced by disconnection of circuits. Survey of overvoltages due to switching operations at three substations on the British 132-kv grid showed highest relative overvoltage recorded was 2.65.

Teletransmissions: System of remote indicating, telephone and telemetering for the British grid was explained by Gunning and Kaufmann. They explained that standardized components of every kind are used; and from these a control assembly can be made up to fit any station or control point as desired. They emphasized that it is the components that are standardized. The system uses ordinary grade Post Office lines with phantom d-c earth return signals for infrequent traffic — general instructions, indications, etc. — and have 10-way time division multiplex band transmission for the high-density telemetering traffic using VF signalling. On lines where d-c signalling cannot be used, 300-cycle signalling is used with 400-cycle high pass speed filters. Lines are rented from the Post Office instead of building separate communication lines.

At present, a study is being made for an 800-kv d-c transmission line between the Stalingrad hydroelectric station and the Donetz coal field. Bykhovsky of USSR explained design of high-frequency communication channels on this line, using ladder type filters to lower the interference level. He also described the hf channels on the 400-kv Kuibyshev-Moscow lines.

Telephone and Radio Interference: On this subject, Adams of USA pointed out that line design and choice between one large conductor or a bundle of several smaller conductors is of first importance. Spacing between conductors of the bundle and between phases can also be used as control variables. In general, by extrapolation of present practice and especially by use of bundled conductors, power transmission at voltages as high as 1000-kv is now possible with presently acceptable levels of interference. In addition, use of bundled conductors appears to offer a better compromise between require-

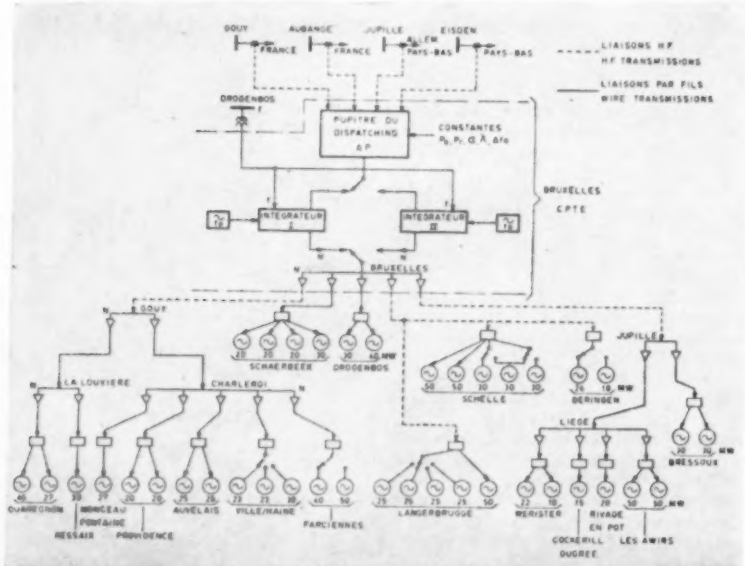


Fig. 17. Schematic diagram of the control equipment installed in the Belgian power system. Pupitre de dispatching—control desk; integrateur—integrator

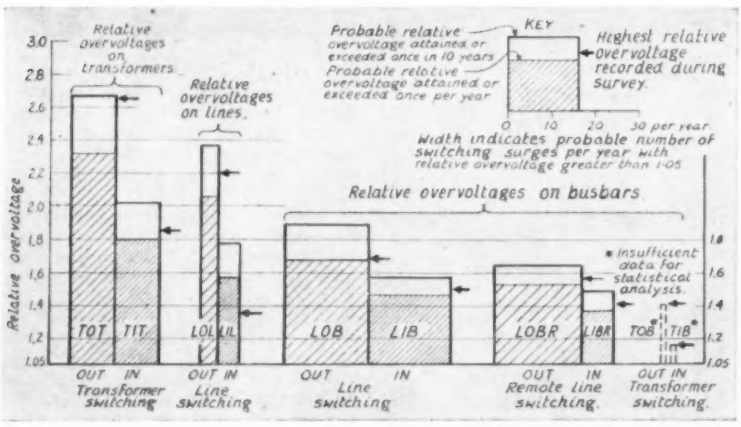


Fig. 18. Frequencies of occurrence and relative magnitude of overvoltages due to switching operations, as reported in the operation of the Grid in Great Britain

ments of conductivity and radio interference than use of single conductors alone.

Other speakers discussed effects of corona discharge, protection of telephone lines entering substations, interference with television reception and so on. Telephone and radio interference on the Swedish 100-kv, d-c Gotland line was discussed. Provisions made on the d-c design were adequate, but on the 130-kv a-c feeder side, a filter had to be inserted to reduce interference.

HIGH-ALTITUDE corona and radio influence measuring installation at Leadville, Colorado, was described by Robertson and Wagner of USA. Public Service Co of Colorado expects to build transmission lines at higher voltages than the existing 115-kv circuits, some of which have an average altitude of 10,000 ft and cross the Continental Divide through passes of 12,000 and 13,000 ft. altitude. Construction is difficult, and mechanical loading severe during storms. Therefore simple tower design and minimum conductor size with good corona and radio influence is important.

To evaluate these, in coöperation with several manufacturers, a transformer has been installed adjacent to the Leadville substation, to supply a new test line with voltage to ground varying from 153 to 289-kv. The line is 6700 ft long, maximum span length 2072 ft, altitude 10,000 ft. Structures include steel tower and steel and wood H-frames. Conductors are single, two-conductor bundle and a four-conductor bundle, which has been reduced to a three and then to a two-conductor bundle. Instrumentation is automatic recording of voltage, current, corona loss, radio influence, weather conditions. Motor-operated switches disconnect two conductors for a test on the third at intervals. Preliminary test results were reported and compared with an analysis previously made at Tidd Station of AG&E.

Extra-High-Voltage Systems: Discussion of the high-voltage systems

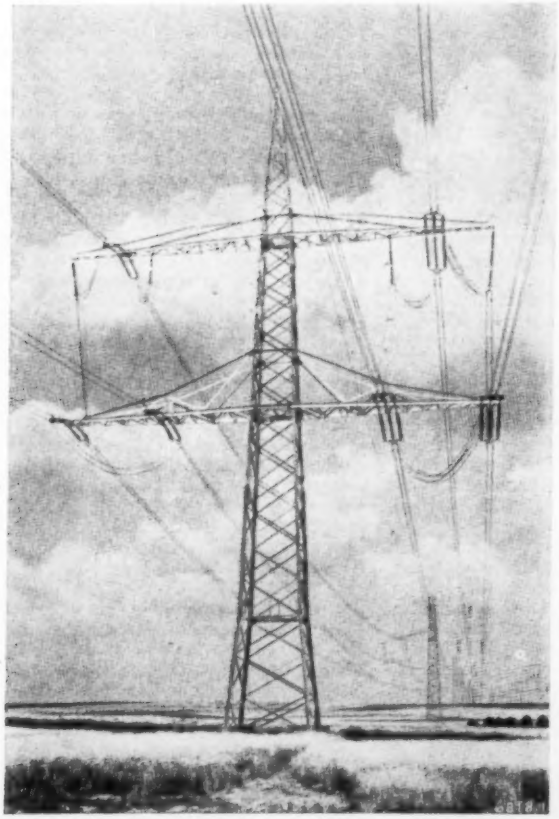


Fig. 19. For German 380-kv power system. Left-hand system: 220-kv double bundle. Right-hand system, 380-kv 4-bundle

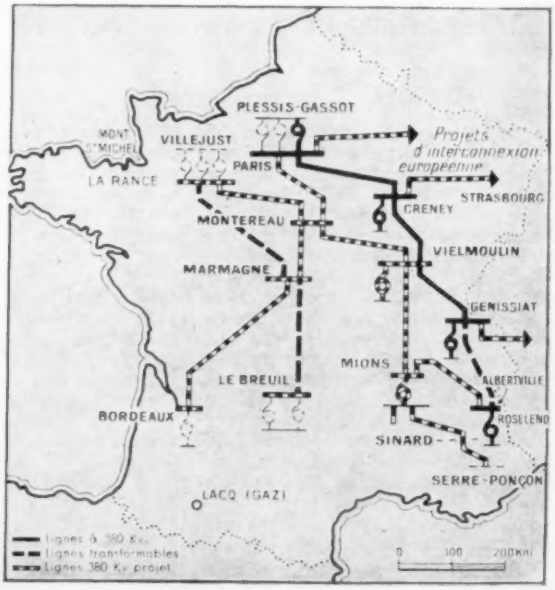


Fig. 20. French 380-kv system in 1958 and subsequent stages of growth to 1965. Solid line shows present 380-kv

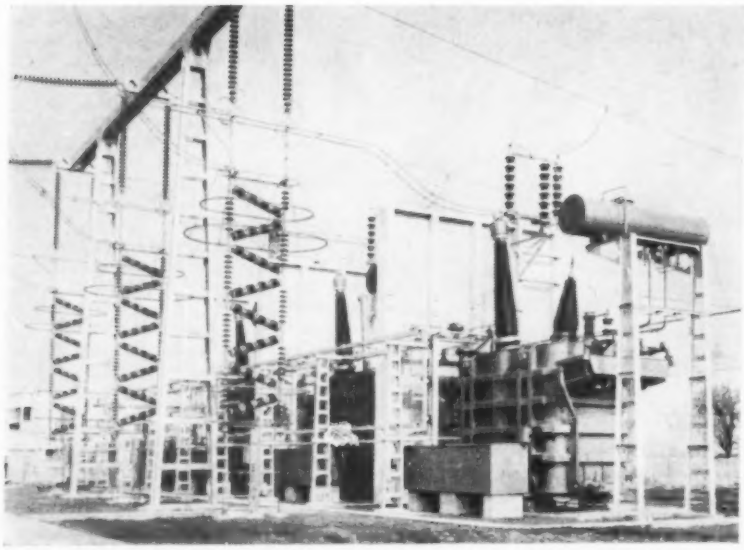


Fig. 21. View of part of the substation of Plessis-Gassot, near Paris, for transformation of 380 kv to 225 kv and 10.5 kv. Capacity of substation is 300 mw

now undergoing rapid expansion in Europe formed an important feature of the CIGRE meeting. All over the world, electric power loads are increasing, hence the capacities of both existing and new systems must increase. For economic reasons, this means transmission at higher voltages.

Very important systems, said Philip Sporn, USA, chairman of International Study Committee No. 9, are now operating at 380 to 420-kv in Sweden, the USSR, Germany and France. This voltage will soon be utilized in Finland. Use of 345-kv (and 360-kv in certain cases) is rapidly developing in the United States and Canada. In Russia, plans are under way for transmission at 800-kv direct current. In the United States, also, an experimental line for studying operation at 700-kv will soon be built. In Australia an extensive 330-kv system is being built, while in Great Britain and Japan the 275-kv systems are being constantly extended. Moreover, through interconnections, power is being or can be interchanged between the various countries of Europe to meet various conditions; this is done by agreements between them. Furthermore, plans are well advanced for a direct-current submarine cable to be installed to connect the British grid with the French system across the English Channel.

In Germany, said Gloyer and Vogelsang, the transmission lines of the West German 380-kv system were built by several utility companies but all of identical construction, to develop a uniformly planned system that would meet future transmission needs. Towers are designed for two 380-kv circuits and bundled conductors, Fig. 19. Mechanical tension on conductors is low, with low vibration, and bundled conductors also have low vibration. Rod type insulators are used. Tower foundations are separate concrete blocks. The lines are shielded against direct lightning strokes by ACSR cables the whole length. One circuit 340-km long was put into service in 1957 between Rommerskirchen substation near Köln and Hoheneck substation near Stuttgart.

The first French 380-kv line from Genissiat to Paris was put into service in 1958. Its interest is that 10 years ago, a line of towers was set up designed to carry a 380-400-kv horizontal phase configuration but on which were temporarily installed two 225-kv circuits of 6 cables horizontally spaced. These 225-kv circuits have now been converted into a 380-kv single line equipped with bundled conductors.

In all seasons, even in times of great drought, a very important peak power is sent from the South to the North of France, so as to benefit by the low peaktime production costs in the mountainous areas. When hydraulic conditions are good, the daily utilization of these transmissions is very important. On the contrary, when hydraulic conditions are poor, the South-North transmission is of short duration and during off-peak hours the direction is reversed and thermal energy is sent from the North to the South.

Besides, new facts such as the development of the natural gas strata of Lacq, or interconnections with the adjoining countries, also have an influence on the structure of the system.

For more than 15 years the prospect of the future powers to be transmitted has set the problem of the superimposition of a higher voltage system on to the general 225 kv French system.

The question has been whether it was more advisable to introduce early a new voltage or, on the contrary, to delay this introduction as long as possible while extensively developing the 225 kv system; this latter solution being made possible by the fact that transmission distances are appreciably shorter in France than in Sweden, for instance, and do not in themselves require a higher voltage than 225 kv.

Early changing over to the new voltage prematurely entails very great expense. On the contrary, its delayed introduction would mean savings at first, but would jeopardize the future, for an excessive number of 225 kv lines remaining in parallel with the subsequent higher voltage system would represent a badly utilized capital, which might obviously have been better employed in developing the higher voltage system.

Solution was found in the idea of building the new lines in the form of 225-kv double lines designed to be converted subsequently into single lines at a voltage as high as 400 kv.

In these conditions, a first line between the Massif Central and Paris was equipped with towers carrying, in a horizontal phase configuration, six conductors forming two 225-kv circuits, which it was possible later on to regroup two by two, to form a single circuit at the higher voltage.

This higher voltage, which should be the same for all the countries likely to be interconnected, was fixed at 380 kv during the meetings of the International Electrotechnical Commission at Lucerne in 1947.

Since then, several double lines designed according to the same principle have been commissioned, in particular the Albertville-Genissiat, Creney, le Plessis-Gassot line which was commissioned in 1953 and the purpose of which was to reinforce the Alps-Paris interconnection.

Convertible lines have thus made it possible to prepare gradually the structure of the future 380-kv system, the date of the change over to this voltage depending on two conditions: on the one hand, having a sufficient amount of power to transmit between the production and consumption centers and on the other hand, still having, after the change over to 380 kv, an adequately-meshed 225-kv system ensuring a sufficient operational reliability able to protect it, for instance, against losses of synchronism.

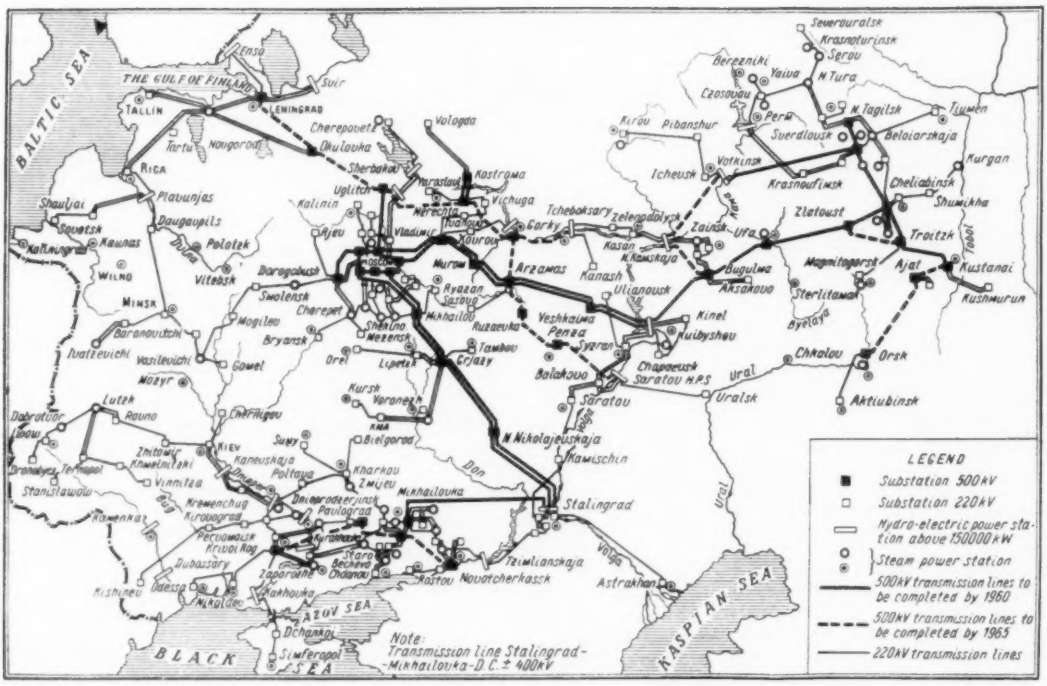


Fig. 22. Diagram of 500-kv power system planned for 1960 and 1965 in the European part of the Soviet Union

These are the considerations owing to which the decision of building the 380 kv system was postponed until 1956, but the forthcoming putting in service of new power plants in the Alps area and in the Rhone Valley has led, as a first stage, to change over to 380 kv the 520 km long, 225-kv Albertville-Genissiat-Greney-le Plessis-Gassot double line. This change-over has been done in two stages: the first 446 km long Genissiat-le Plessis-Gassot section was put in operation early in March 1958; the second section, Albertville-Genissiat will be put in operation at 380 kv during 1959.

The commissioning at 380 kv of the first Alps-Paris line will be followed, within three to four years, by the commissioning of a second line operating in parallel with the first, while following a slightly different route. This second line will become necessary when the whole of the installations at la Bathie, the power stations on the Durance river, and the new power plants in the Rhone Valley are put in operation.

At the same time as the Alps 380-kv system, a second system will be developed in the Western part of France. This second 380-kv system will include, on the other hand, the first convertible line which was built in 1946 and which will link the Massif Central and Paris, and on the other hand, a Bordeaux-Montereau-Paris link, which will ensure the transmission of the production of the Southwestern area of France where new power plants utilizing natural gas fuel will be built.

Conversion of 115-kv lines to 230 kv and subsequent operation at voltages up to 262 kv by the Hydroelectric Power Commission of Ontario was reported by Simpson and Ogorodnikov. This was done by increasing the insulation by adding two insulator units on each suspension string and providing somewhat larger clearances at a few locations. In 20 months, only three sustained outages have occurred, one from lightning, two from cross-arm burning.

Test results and operating experience on the Kuibyshev-Moscow transmission system in the USSR were given. On the basis of experience with the first 400-kv line, it was decided to convert, in the near future, the 400-kv transmission systems in operation and under construction to 500-kv, and to design all new long-distance transmission systems for 500-kv. At present, the Kuibyshev-Urals and Stalingrad-Moscow transmission lines are under construction. By 1960,

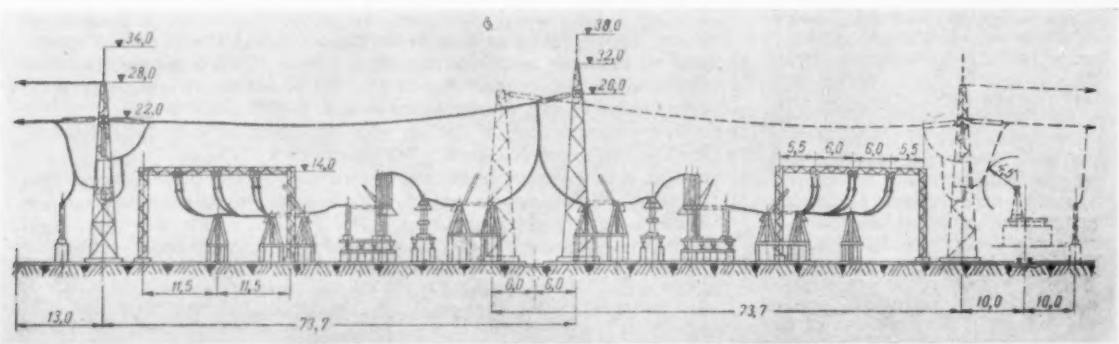


Fig. 23. General elevation of a new 500-kv outdoor switching station designed for the power system of the Soviet Union

they will tie together the large power systems in the European part of the Soviet Union through 500-kv lines and then engineers will start consolidating the power systems of Siberia. The Russian authors reported details of reclosing, reactive power, corona losses, system stability, overvoltages and insulation levels and so on. By increasing the rated voltage of existing transmission lines from 400 to 500 kv, they will increase transmission capacity by 40 per cent, and cut line and corona losses, although substation equipment costs more.

Aspects of latest plans for the British 275-kv scheme for 1960 were treated by Cash and Chorlton. The main transmission system in England and Wales consists of a 132-kv network, established 25 years ago and now comprising over 4600 route-miles of 132-kv line, mostly double-circuit, with 365 switching and transforming stations; and a 275-kv network, in which the first circuit was commissioned in 1953 and the initial phase of development is due to be completed in 1960. At present 612 route-miles of 275-kv line are in commission, 141 miles being temporarily operated at 132 kv.

The 132-kv network comprises seven areas, with fringe connections between adjacent areas. Each area has its own control center operating at the direction of a national control center, continuous parallel operation being maintained between all areas and also with the system of the South of Scotland Electricity Board.

The 275-kv network now planned for 1960, together with certain projected later developments was explained. Excluding the connection to Scotland but including four short sections to operate initially at 132 kv, the scheme for 1960 comprises some 1700 route-miles of 275-kv overhead line and 46 substations, with a total 275/132-kv transformer capacity of 13,500 mva. This represents a 50 per cent increase in line mileage and a doubling of the number of substations in comparison with the scheme originally envisaged for 1960, the main features of which were reported at the 1952 Session of CIGRE (Papers No. 401 and 229). Two sizes of conductor are employed. The light-duty lines, used mostly in the north of the country, have twin 0.175-sq in conductors on each phase, giving a thermal rating of 375 mva per circuit. The heavy-duty lines, which comprise three-quarters of the total mileage for 1960 and are being adopted for all future lines in strategic positions, have twin 0.4-sq in conductors, giving a thermal rating of 750 mva per circuit, the towers being constructed with sufficient clearances to permit of an increase to 380 kv if required in the future.

Further details of the interesting British plans for the future, through 1965, including development of nuclear power stations, will be given in a subsequent issue.

Table giving summary of reclosing performance on the 345-kv system of the AG&E, now American Electric Power Co. Data are based on oscillographs

		LIGHTNING									SLEET				PERMANENT				IMPROPER RELAYING		
		SINGLE CIRCUIT					DOUBLE*												SINGLE END TRIPS ON EXTERNAL FAULTS		
	CIRCUIT	TOTAL	UHS - BOTH ENDS	REFAULTS	UHS 1-END: UHS OUT	UHS 1-END: OTHER	TOTAL	UHS - ALL ENDS	UHS - 3ENDS	REFAULTS	TOTAL	UHS - BOTH ENDS	REFAULTS	UHS OUT, ETC	TOTAL	TERM EQUIP	CRANE	TORNADO	TOTAL	UHS	RETRIP
AG&E CO	TANNERS CK. - SORENSON	10	8			2					2		2						1	1	
	SORENSON - E.LIMA	8	8								5	2	1	2							
	E.LIMA - MUSKINGUM	5	4		1						17	1	10	6	6	5	1				
	MUSKINGUM - SPORN	1	1																1	1	
	SPORN - KANAWHA	8	8																1	1	
	SPORN - KYGER																				
	TOTAL - AG&E CO.	32	29	0	1	2					24	3	13	8	6	5	1	0	3	3	0
OHIO VALLEY ELECTRIC CORP	CLIFTY CK - DEARBORN # 1	6	6																		
	CLIFTY CK - DEARBORN # 2	2	2												1	1			1	1	
	CLIFTY CK - PIERCE # 1	8	8																1		1
	CLIFTY CK - PIERCE # 2	9	7	1	1										2	2			1	1	
	DEARBORN - PIERCE # 1	3	3				1	1											2	2	
	DEARBORN - PIERCE # 2	3	3																2	2	
	PIERCE - X530 # 1	5	5				1	1			11	2	9						1	1	
	PIERCE - X530 # 2	8	8								2			2					1	1	
	PIERCE - X553 # 1	7	5	1		1	1		1												
	PIERCE - X553 # 2	7	1	1	5						2		2						1	1	
	KYGER CK - X530 # 1	3	3												1			1	1	1	
	KYGER CK - X530 # 2	6	2	1	1	2									1			1	1	1	
	KYGER CK - X533 # 1	2	2				1	1											1	1	
	KYGER CK - X533 # 2	1	1																3	3	
	TOTAL - OVEC	70*	56	4	7	3	4	3	1	0	15	2	11	2	5	3	0	2	16	15	1
TOTAL AG&E AND OVEC		102*	85	4	8	5	4	3	1	0	39	5	24	10	11	8	1	2	19	18	1

*DOUBLE CIRCUIT INCLUDED IN SINGLE AS 1 OPERATION FOR EACH LINE

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(17th International Conference on Large High-Tension Electric Systems) Session 1958 – June 4 to 14

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A Look at American Engineering Education and Training

By K. R. STURLEY

THE FOREIGNER finds it easier to understand your educational system once he realizes that your schools have had to fulfill a sociological as well as an educational purpose. Your generous acceptance of 20,000,000 immigrants over the past 60 years — immigrants from many countries of differing traditions and cultures — has enriched your own life but has at the same time presented social and linguistic problems which your schools have had to help solve, and inevitably there has been some loss to education, the chief sufferers being your brighter students whose progress has been retarded by being kept to the speed of the average.

According to the New York *Times* of November 2, 1957, the better students are also "inhibited by a hostile anti-intellectualism from their colleagues." This characteristic is naturally not confined to America, but I formed the impression that it was much more widespread than in Europe, for example.

It should in fairness be said that favorable comment has been made in Great Britain on the freshness of outlook and eagerness of the American university student, for it is claimed that many of our children are pushed too hard and come to the university somewhat jaded and narrowly specialist. However, at one of your famous universities I was told that the first year is taken up with making the student realize that there is no substitute for hard work and that difficulties are there to be surmounted and not avoided.

I was surprised at the low esteem in which your school teaching profession is held. Even though salaries in the United Kingdom may not be as high as we would wish, the profession here is highly regarded and the teacher has an honored place in our society. Through our Ministry of Education and the universities we have been able to establish an overall standard of education in our schools without placing our system in a straitjacket, and I felt that the lack of an American nation-wide standard (surely most important in these days of rapid change) was too high a price to pay for asserting your strongly individualist outlook.

The contrast in the treatment accorded to an American boy or girl on leaving school is staggering, a high proportion of your good quality high school students being thrown in at the deep end and expected to fend for themselves. Earning while learning is therefore a commonplace with you, whereas our policy is to provide a system of maintenance grants (scaled to parents' income) as well as payment of tuition fees. My own guess is that you will come a long way towards our view before the century is out.

Technical Education

Community colleges have an important part to play in training the technician and I saw evidence of some very good work going on in New York. In the engineering departments you appeared to have reached the same conclusions as ourselves, viz, that a correct balance should aim at an almost equal division of time between theory (lectures) and practical (laboratory) work.

The Engineers' Council for Professional Development is now undertaking the accreditation of technician courses and this should help remedy what I think is a disadvantage, namely, your lack of nation-wide control of standards. In the United Kingdom technician training is largely carried out under the auspices of our City and Guilds of London Institute which exercises control through set examinations.

Recently an Electrical Technician's Certificate has been instituted and it involves a four-year part-time course with specialization in power engineering or industrial electronics in the final year. This is a comparatively new venture, but the City and Guilds for some long time have been carrying out very successful courses for technicians in the communications industry. As far as I could judge, your community colleges, with their two-year full-time course, bring the students up to a standard a little higher than that of our four-year part-time City and Guilds courses.

We have more advanced technician courses leading to what is known as a National Certificate and the standard of these is controlled through the Ministry of Education in association with the Institution of Electrical Engineers. As far as I could ascertain, the standard of our Higher National Certificate man is above that of your community college student. We have means by which the best of the National Certificate students may eventually reach professional engineering status by taking further advanced courses.

I detected some concern at the emphasis at present placed on the pre-university two-year course at the community colleges. The proponents argue that it reduces the cost to the student by allowing him to spend his first two university years near his home. I think there are some disadvantages in one institution trying to operate both technician and undergraduate courses. There is a tendency for either the technician course to be a watered-down version of the undergraduate course, or for the undergraduate course to have insufficient emphasis on fundamental physical principles.

I was impressed with the standards achieved by some of your profit-making technical institutes. We have very few examples of this type of institute in Great Britain because education is mostly controlled through the Ministry of Education. Your wide-open spaces also encourage the use of correspondence courses which undoubtedle fulfil a very useful purpose; however it must always be recognized that they can never do as well for the student as formal teaching, provided the numbers in the class are not excessive.

Engineering Graduate Education

Entry to your university colleges and institutes of technology seems to depend less on success in examinations than with us, though I noticed that the College Entrance Board examination is used as an entrance qualification by a number of institu-

K. R. STURLEY, Head of Engineering Training in the British Broadcasting Corporation, is responsible for all training of a staff of about 4000. He is a graduate in Electrical Engineering of the University of Birmingham, England, holds the Ph.D. and B.Sc. degrees, and is a member of the Institution of Electrical Engineers.

Last fall, Mr. Sturley spent five weeks in this country studying our technical education and training methods. POWER ENGINEERING asked him to set down his impressions of this vital part of American engineering life.

tions. Your university standards appear to be much more variable than are our own and I think this is due partly to the fact that you do not use external examiners, partly to your insistence on complete autonomy and partly to the fact that your professional institutes do not themselves run qualifying examinations. I should perhaps make it clear that the British professional institutions do not dictate to the universities, but the fact that they have their own examinations does I think have some influence in maintaining standards.

Our own university students often seek paid employment during their vacations but this period is regarded as a means of adding to practical experience rather than as a means of replenishing the exchequer. It would be most unusual to find any university or college-of-technology student undertaking paid employment during a semester.

Undergradute Training

Formal instruction rather than self instruction appears to be the keynote of your undergraduate training and it is perhaps understandable because of your lower educational standards at entry. This principle is carried into your training for higher degrees and I think it helps to explain your outstanding progress in the field of development and design. I am not sure that so much emphasis on formal instruction is wise for the first-class research student (relatively few in number in any country) because he should be a natural rebel from accepted ideas and his greatest value is in striking off on an unexplored track.

More stress is laid on teaching the humanities in America than in Britain, but your students — if I may say so — did not appear to be any more cultured than our own. Some editors of journals that I met complained, just as they do in Great Britain, of the poor intelligibility of articles submitted by graduates. My own view is that it is very difficult to teach the humanities. Much more can be done by example, and the engineering student will only become cultured through the agency of his home background and through his teachers themselves having broad interests. Of these two probably home background has the greater influence.

I was impressed with the free and easy social relationship between students and professors; this could very well be a result of the social training at school.

The number of students taking part-time evening courses leading to degrees is very much greater than in Great Britain. Our own experience is that this method does not really produce the first-class man except in rare cases. Some people here claim that the man, after seven or eight years of part-time study, is rather like a sucked orange.

It was surprising to find so few examples of industrial training for technicians. There appeared to be a few training schemes for giving advanced instruction to trouble-shooters and inspectors, but most technicians were expected to learn on the job.

Industry in Great Britain trains technicians in specialist activities, and some public corporations — including the BBC — have residential centers where the staff, withdrawn from their normal duties, undertake courses in the operation and maintenance of apparatus. These courses generally start with a revision of those fundamental principles required for an understanding of the apparatus on which the specialist training in operational or maintenance techniques is to be given.

We have found that a gap between training and the use of the newly-won knowledge (especially if it concerns operational techniques) should at all costs be avoided and also that a technician should not be overtrained. It is better to give further training just prior to the technician's extension of his sphere of activity.

These same principles had been appreciated and applied in an American industrial technician training scheme which compared favorably with the kind of schemes we operate in Great Britain. It was the only one I saw that reached our standards, though I realize that time only allowed me to visit a small fraction of your industrial establishments. I found that on the whole American practice was more conscious of the need to give management training to all types of staff, including technician supervisors, than were we. You benefit from the much larger number of people taking university courses; many of these fail to achieve a degree and help to swell your technician group.

Graduate Training in Industry

Your schemes seem to be quite as advanced as our own and there is little difference between American and British practice. Like you we have our induction period, our rotational assignments and our post-graduate study, etc, but there is not the same emphasis on obtaining a further degree, and part-time preparation for higher degrees is much more difficult in England.

We lay emphasis on some basic workshop training for graduates in electrical engineering, but you do not seem to demand this; one executive described your attitude to this question as, "We pay for the brains of the engineer and not for his hands."

Inquiries about the availability of graduates for electrical engineering elicited the information that they were in short supply, but a number of your executives felt that stock-piling had occurred and should a slump overtake you a large number of graduate engineers would appear on the market. Some professors felt that graduate engineers were not being properly used and that many were being employed on what were really technician duties. The public utility companies were thought to be guilty of misusing talent in this way.

I can sympathize with this point of view because when interviewing a graduate who has worked on technician duties for some time I have found his reasoning process atrophied, and he is often worse technically than a technician who has pulled himself up by his own shoe strings. On the other hand he is seldom beyond recall and can usually be brought back to his original technical standard after transfer to graduate quality work.

General Observations

There are a number of features in American industrial society that are of interest to a foreigner. The habit of using Christian names between chief and subordinate creates an informal atmosphere which appears to improve communication.

The close study of human relationships has been of considerable value in improving staff morale and hence staff output, but it seems to have led to a passion for an assessment of people in almost machine-like terms and to an obsession concerning "what the boss thinks of me." The spirit of enterprise is very marked and gives a buoyancy which encourages the American to tackle the impossible. Unionization of industry, with its consequent stress on seniority, seems to be discouraging movement from company to company just as much as the non-contributory pension.

Corporate membership of a professional society seems easier to achieve in America than in Britain. We demand that an accredited graduate shall have undergone a 2- to 5-year period of practical training and shall have held a responsible position for at least two years before he is considered for Associate Membership. Technicians are not accepted for corporate membership and we feel that their best interests are served by forming corporate organizations of their own. However, we have no national scheme for registering engineers.

In concluding may I say that though some comments have been critical I hope it will not be thought that I underrate America's achievement in the field of technical education and training. There is much we can learn from a study of your methods, your free and easy manner, your attitude to the "impossible," your insistence on self-help, and your urge to find something new.

Equally, our system has features which would, I think, repay your study; the more significant role of the school teacher in our community, the fairly widespread non-uniformity of our educational methods, which allows full play for the budding genius, the corporate sense of our responsibility to the less successful individual, and our sense of tradition and conservation. We can, I am certain, profit considerably from an examination of each other's successes and failures. THE END

By including a gas turbine and using a supercharged boiler with a new steam turbine installation, over-all cycle efficiency may be raised four per cent or more on the largest, most efficient units, up to eight per cent on smaller units. Dollars per kilowatt initial cost should also be ultimately decreased

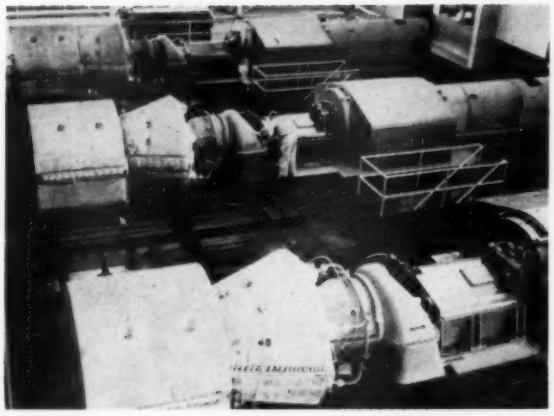


Fig. 1. Mene Grande Oil Corp power plant consists of three 5000-kw gas turbine generators, has a remarkable reliability record after four years' operation, typical of records gas turbines are establishing everywhere. A fourth unit will soon be added

Why a Combined Steam and Gas Turbine Plant?

By J. O. STEPHENS *

STEAM POWER has been the mainstay of the power industry since its birth. By successive improvements through the use of higher throttle pressures, temperatures, regenerative feedwater heating and reheating cycles, power plant designers have been able to achieve a steady reduction in plant heat rates over the years to offset the continuous rise in fuel and labor costs.

However, this continued improvement is becoming slower and more difficult within the limitations of increased costs of materials for higher temperatures and pressures.

When the complete steam plant is surveyed from a thermodynamic viewpoint, it is noted that there are two fluid mediums employed; namely, steam through the turbine and gaseous products of combustion through the boiler. Considerable effort has been and will continue to be expended on extracting more work from the steam medium, with smaller rewards for the effort expended.

Extracting work from the gas side of the cycle in addition to that obtained from the steam offers an added bonus in converting heat energy to electrical energy. Thus, this article is concerned with extracting work from the gas side of the cycle where the maximum improvement can be made with the present state of development of high-temperature materials.

Since large volumes of hot gases are required for a boiler and since gas turbines use and exhaust large volumes of hot gases, it is only natural that combining the gas turbine with a boiler complements each cycle.

Two avenues of approach to the integration of the two cycles are available. One is to use the hot exhaust gases from the gas turbine for boiler combustion air and the other is to combine the combustion in the gas turbine with that of the boiler.

Alternate Methods Compared

Of these two methods the first has a smaller gain in over-all thermal efficiency with a range of two per cent to four per cent depending upon the efficiency level of the steam plant. The second has a gain of four to eight per cent in efficiency, again depending upon the over-all level of efficiency of the steam plant to which the combined cycle is compared. The exhaust-gas combination is an intermediate step inasmuch as it can, if required, be separated from the steam cycle and both plants be operated independently.

Several installations of this type are in service in this country and confirm all calculations as to improvement in efficiency. For this combination the author's company has gas turbines in production that could be used to form the intermediate combined-cycle plants of the sizes shown in Table I. Combinations and multiple units of these gas turbines can provide an optimum combination for a wide range of power plant sizes.

For the second type or supercharged-boiler combined cycle, the boiler is pressurized with the air from the gas-turbine compressor and the hot exhaust gases from the boiler are expanded through the gas turbine.

Added gain in this plant over the exhaust-gas combined plant is due primarily to the expansion of the increased fuel in terms of mass flow through the gas turbine, and to the greater expansion ratio of the increased combustion products. A conversion efficiency to work of 85 to

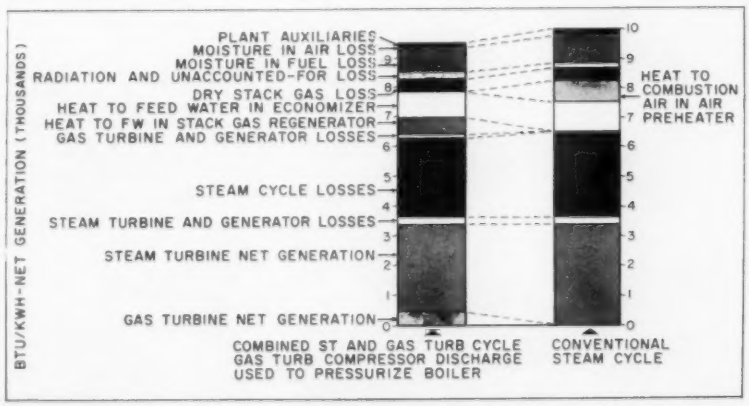

BTU/KWH-NET GENERATION (THOUSANDS)
PLANT AUXILIARIES
MOISTURE IN AIR LOSS
MOISTURE IN FUEL LOSS
RADIATION AND UNACCOUNTED-FOR LOSS
DRY STACK GAS LOSS
HEAT TO FEED WATER IN ECONOMIZER
HEAT TO FW IN STACK GAS REGENERATOR
GAS TURBINE AND GENERATOR LOSSES
STEAM CYCLE LOSSES
STEAM TURBINE AND GENERATOR LOSSES
STEAM TURBINE NET GENERATION
GAS TURBINE NET GENERATION
HEAT TO COMBUSTION AIR IN AIR PREHEATER
COMBINED ST AND GAS TURB CYCLE
GAS TURB COMPRESSOR DISCHARGE USED TO PRESSURIZE BOILER
CONVENTIONAL STEAM CYCLE

Fig. 2. Cycle loss comparison, combined steam and gas turbine *versus* steam only

* Section Manager, Industrial Gas Turbine Engineering, Steam Division, Westinghouse Electric Corp

Table I. Economical combinations with production models of gas turbines, exhaust being used as boiler combustion air

Gas Turbine Kw Output	Combined Plant Kw Rating	Steam Conditions
2500	19,000	850 psig, 900 F
4000	30,000	850 psig, 900 F
5700	50,000	1450 psig, 1000 F, 1000 F
9700	87,000	1800 psig, 1000 F, 1000 F
18,800	170,000	2000 psig, 1050 F, 1000 F

Table II. Using same gas turbines as Table I, output is increased when the boiler doubles as the gas turbine combustor

Gas Turbine Kw Output	Combined Plant Kw Rating	Steam Conditions
3300	19,000	850 psig, 900 F
5200	30,000	850 psig, 900 F
7500	50,000	1450 psig, 1000 F, 1000 F
12,800	87,000	1800 psig, 1000 F, 1000 F
24,800	170,000	2000 psig, 1050 F, 1000 F

90 per cent occurs in the gas turbine rather than transferring the heat contained in this increment of fuel to generate steam and then extract the energy at a 35 to 45 per cent level.

Normally the gas turbine fuel amounts to one per cent of the flow through the turbine with 400 per cent excess air. When combined with the supercharged boiler with ten per cent excess air the per cent fuel increases to approximately five per cent.

Since for every three units of work generated by the gas turbine approximately two units are absorbed in the compression of air, an increase of one per cent in turbine work represents three per cent increase in output. As no additional air is required, the four per cent increase in fuel flow represents a 12 per cent increase in gas turbine output plus an additional 12 to 15 per cent due to greater expansion in the products of combustion.

This gain when effectively applied to obtain the optimum feedwater-heating cycle results in the improvement of this cycle over the exhaust-gas combined cycle. The distribution of heat for the supercharged-boiler combined plant is shown in Fig. 2.

Using the same sizes of gas turbines as listed above, the supercharged-boiler combined cycle results in the sizes of combined plants shown in Table II.

High Reliability

There has been a natural reluctance on the part of the electric utility industry to completely integrate a large power plant with a relatively new prime mover such as the gas turbine until such time as the reliability of the gas turbine had been established.

In the early 1950's the industrial gas turbine began to be applied for power generation, and by 1955 more than 1,000,000 horsepower had been applied to commercial installations around the world. Today more than 4,000,000 horsepower has been installed or is being built.

Some of these units have already completed in excess of 40,000 hours of operation, with reliability as high as 99.7 per cent carrying average continuous loads as much as ten per cent in excess of nameplate rating, and with maximum continuous cold weather loads of 40 per cent above rating.

Thus, in a few short years the gas turbine has been accepted by many users as a prime mover comparable with other power-plant apparatus.

The fully-integrated supercharged-

Table III. Coal-fueled combined-plant efficiency compared with steam plant range

Combined Plant Kw Rating	Steam Conditions	Gain in Efficiency Over Comparable Size Steam Plant
50,000	1800 psig, 1000 F, 1000 F	5.2
580,000	3500 psig, 1050 F, 1050 F, 1050 F	4.2

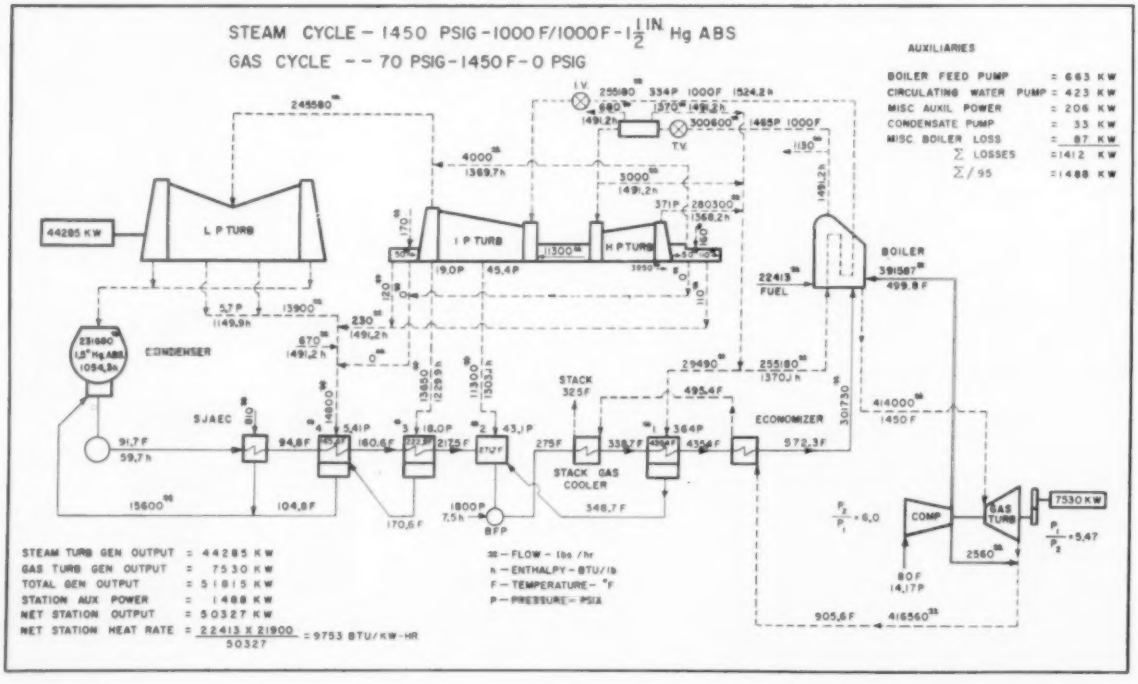

STEAM CYCLE – 1450 PSIG – 1000 F/1000 F – 1½ IN Hg ABS
GAS CYCLE – – 70 PSIG – 1450 F – 0 PSIG
AUXILIARIES
BOILER FEED PUMP = 663 KW
CIRCULATING WATER PUMP = 423 KW
MISC AUXIL POWER = 206 KW
CONDENSATE PUMP = 33 KW
MISC BOILER LOSS = 87 KW
Σ LOSSES = 1412 KW
Σ / 95 = 1488 KW
L P TURB
I P TURB
H P TURB
44285 KW
BOILER
FUEL
CONDENSER
SJAEC
ECONOMIZER
STACK
STACK GAS COOLER
BFP
COMP
GAS TURB
7530 KW
STEAM TURB GEN OUTPUT = 44285 KW
GAS TURB GEN OUTPUT = 7530 KW
TOTAL GEN OUTPUT = 51815 KW
STATION AUX POWER = 1488 KW
NET STATION OUTPUT = 50327 KW
NET STATION HEAT RATE = 22413 X 21900 / 50327 = 9753 BTU/KW-HR
W = FLOW – lbs / hr
h = ENTHALPY – BTU/lb
F = TEMPERATURE – °F
P = PRESSURE – PSIA

Fig. 3. Heat balance for combined steam and gas turbine cycle. Economizer and stack gas cooler extract exhaust heat

boiler combined plant offers new innovations and concepts of steam generation that have been investigated by several boiler manufacturers. Figure 4 is an arrangement study for such a combined plant of 50,000-kw capacity where the gas turbine is one that is in current production.

A complete heat balance for this 50,000 kw combined plant is shown in Fig. 3. This shows a combined heat rate of 9753 Btu per kwh while the steam plant in this size and with the same steam conditions would be 10,440 Btu per kwh, representing a gain of 6.6 per cent. Such a plant using natural gas fuel requires only the selection and matching of components to be a reality.

Fuels for Combined Cycles

Most gas turbines that have been installed to date operate on natural or refinery gas. This premium fuel in certain areas is available at prices very favorable to its use in power generation. With the trend for transporting this fuel to domestic heating areas, the price is increasing and will continue to increase until the delivered price of gas and oil are comparable.

Thus the owners of power plants that use natural gas are extending their search for more efficient plants in areas where gas is abundant. For them the pressurized-boiler combined cycle is available now, and is the next major step on the road to more efficient power generation.

Although there are numerous steam plants currently being fired with natural gas, it is realized that the future large scale application of the combined cycle will only come when the plant can be fired on coal. Recent developments in better fly ash separation and better appreciation for gas-stream velocities and their relationship with blade erosion are bringing closer the day of the coal-burning gas turbine. In fact, these effects, coupled with fly-ash impingement on a molten slag bed in a large combustion zone such as a boiler furnace, indicate that current gas turbines with relatively low gas velocities will burn most grades of bituminous coal.

Final verification of the coal-burning combined-cycle plant will require a complete installation of such a combined power plant to evaluate not only the erosion in the gas turbine, but the burning and handling of coal under pressure.

Studies have been made using coal as fuel in combined-cycle supercharged-boiler plants ranging in size from 50,000 kw to the 580,000 kw superpressure steam cycle. The results of these two extremes of these studies are tabulated in Table III. It may be noted that even the high efficiency of the superpressure cycle can be substantially improved by the combination with the gas turbine.

Conclusions

The following advantages justify the combination of these two cycles:

1. First, it improves the plant efficiency even when combined with a superpressure plant to form the most efficient large thermal plant that can be envisioned with currently-developed prime movers. This efficiency improvement is realized from half-load to full-load with a very small difference below the half-load point.
2. For the supercharged-boiler combined cycle, it reduces building or plant size for a given rating with every indication of reduced installed costs.
3. Water requirements and size of condenser are reduced for a given rating.
4. Size of many auxiliaries is likewise reduced.

With these large gains in thermal efficiency and with the ultimate possibility of reduced installed costs, a new tool is presented to the power industry for a more efficient method of converting heat energy into electrical energy. Maximum effectiveness of this new tool requires the consolidated efforts of the boiler and turbine manufacturer as well as the operator to achieve the benefits inherent in this highly-efficient plant. Several utilities are now making detailed cost studies on combined plants. THE END

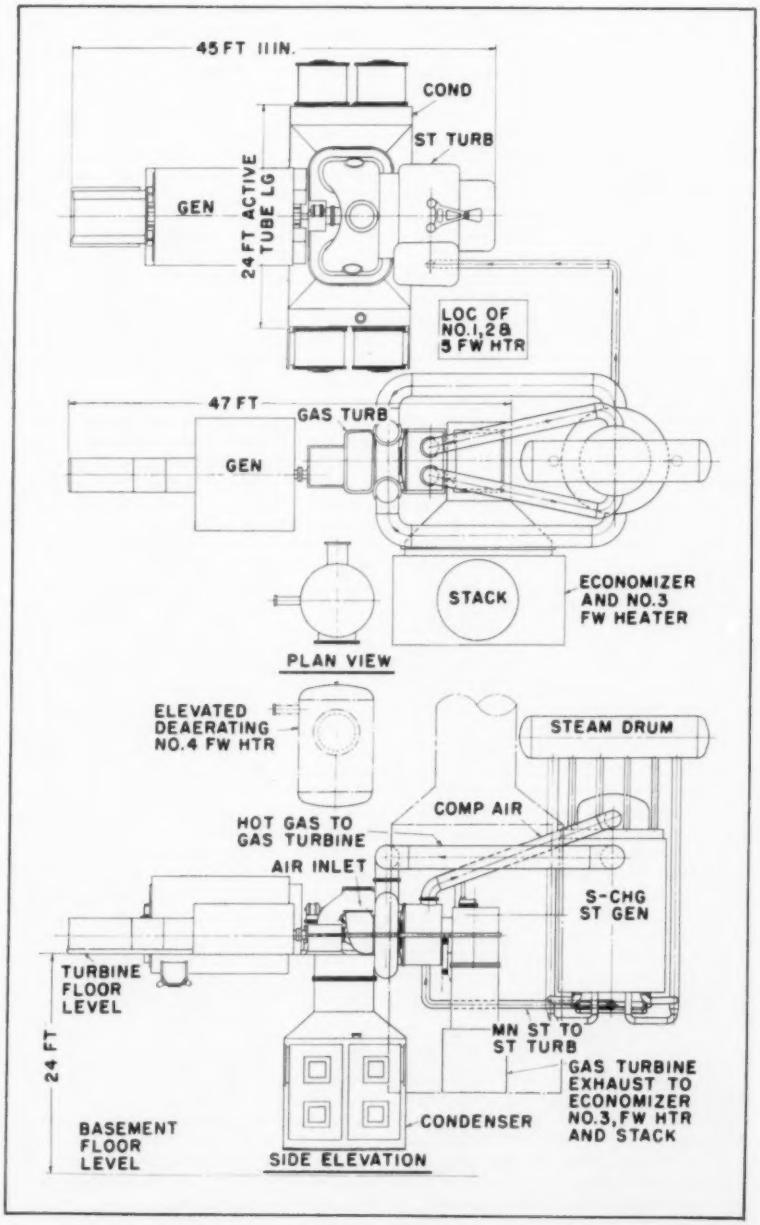


Fig. 4. Arrangement of a 50,000-kw combined steam and gas turbine plant

Deaeration—Which Way is Best?

Condenser or Deaerator?

By W. R. STEUR*

FOR REMOVAL of oxygen, the plant designer will consider either the condenser deaerator or the separate deaerating heater which is a part of the feedwater heating cycle.

The condenser deaerator generally has slight advantage in cost. With regard to performance in itself the story is not so clear. Commercial condenser deaerators are available which have an oxygen guarantee in the condensate leaving the hotwell pump of 0.01 cc/liter. The equipments are, therefore, not directly comparable since their performances are not on the same basis, the deaerating heater having a guarantee of 0.005 cc/liter.

What happens in a typical condensing installation is that the air removal equipment reaches its cutoff point and thereafter requires a virtually constant condenser pressure to remove the air. The effect of this is to increase the partial pressure due to the oxygen in the condenser steam space, which results in a higher oxygen content of the condensate leaving the equipment.

The condensing equipment has the further disadvantage, apart from part-load performance, that on starting up, a considerable volume of air is contained in the steam space, and numerous instances have been cited of the difficulty of removing the resulting oxygen contamination from the system.

In considering the deaerating heater, attention should be given to improved cycle performance which is obtained by having a direct contact heater in place of a closed heater. The effect of eliminating the thermal difference generally results in a lower heat rate by 0.8 per cent.

It is in the matter of performance that the deaerator holds the edge. On start-up, the deaerator may be held at a positive pressure of about 5 psig from an auxiliary steam source, which enables the operator to feed the boiler with zero oxygen water. During brief shutdowns, holding the deaerator under pressure prevents oxygen from entering the heater. The deaerator is capable of operating at small fractions of its rated capacity and still deliver water with low oxygen content.

One of the basic operating factors which makes for inherently better performance in the deaerating heater is the fact that its heating and scrubbing steam is taken from a point in the cycle which has the lowest oxygen.

A great deal of the success in maintaining low oxygen level is related to good operating practice.

* Sargent & Lundy, Engineers

Condenser Hotwells

By A. M. GUY*

FROM an operator's viewpoint, one of the principal disadvantages of a condenser hotwell deaerator system is that each and every condenser or hotwell opening or attachment is a potential source of air inleakage.

Another serious disadvantage is that space limitations and capital investments generally fix the storage capacity of the hotwell, and do not always allow the capacity most desirable for widely fluctuating plant surges.

Major advantage to condenser and hotwell deaeration is that all of the feedwater cycle rather than only a portion of it is benefited by low oxygen water. Another principal advantage is that condenser hotwells may serve to simplify the steam water cycle of a plant by eliminating one or more pieces of equipment.

Another point is that condenser hotwells can be so designed that several minutes more of condensate storage for condensate pump protection may be provided than is usually available when thoroughfare deaeration is employed. When one of these outsized hotwells is attached to the condenser it can readily be used as a surge tank to provide the required volume of water for standby capacity during start-up, shutdown or low load periods when condensate pump recirculation is desirable.

In order to reduce operating manpower as well as maintenance costs to the barest minimum it would seem that equipment such as main condensers and hotwell deaerators located at or near ground floor level are a step further in this direction than deaerating feedwater heaters located six, ten or even 14 stories above ground level. Such a height may add to the operating costs because of the increased hotwell pump head requirements.

Some critics of main condensers and hotwell deaerators have pointed out the difficulty of extracting representative, reliable samples from the main condensers and/or hotwells. Generally, however, such samples are not required; but when this is the case, dissolved oxygen samples are more easily obtained by sampling the hotwell pump discharge, which is normally nearer room temperature, than from a thoroughfare deaerator.

Last but not least, plants having main condensers and hotwell deaeration do not have that continual plume of steam or water vapor normally visible to all passers-by as a constant energy loss.

* Southern Indiana Gas and Electric

Deaerator . . . Plus

By JOHN K. BRYAN*

A DEAERATOR provides a capacity for removing *large* amounts of gases, far greater than would be economical by means of chemical scavengers alone. And a deaerator, unlike the condenser hotwell, can be located in the feedwater cycle so as to operate under *pressure* at all normal loads, precluding the leakage of oxygen into the cycle beyond the deaerator.

Nevertheless, there are a number of tools, both chemical and mechanical, which, together with attention to venting and air infiltration, have an important place in the control of corrosion in the modern high pressure power plant.

In all, some 400 or 500 unit-years of service are represented by Union Electric Co's deaerators, using the term deaerator in a broad sense to cover equipment of varying age and effectiveness.

During the decade from 1920–1930 (Cahokia Plant) "open heaters" were installed as part of each cycle, using auxiliary exhaust steam in the earlier units. The 1940–1950 units (Venice Plant) were each provided with a low pressure direct-contact feedwater heater, plus a deaerator operating at the unusually high pressure of 250 psi. Latest machines (Meramec Plant) have a single 100-psi deaerator, plus a deaerator-type condenser hotwell, and, for two units, low pressure direct-contact heaters in addition.

A deaerator itself *does* require maintenance, despite the fact that there are no moving parts (or at least no parts that are supposed to be moving). It is subject to corrosion, particularly in the vent condenser area; trays and weirs can fall out of place or become misaligned.

Our viewpoint on deaeration is probably best summarized by plans for a 300-mw unit now being engineered. The condenser will feature a deaerating-type hotwell, from which we would expect no more than 0.01 cc per liter oxygen content. Drips, drains and vents will be handled carefully.

Half-way through the cycle there will be a deaerator, designed to operate at 120 psia with full load on the main unit. At reduced loads, the pressure of the extraction steam supplying the deaerator decreases, but is nevertheless above atmospheric pressure all the way down to minimum load (20 per cent). We would expect no more than 0.005 cc per liter oxygen content in the feedwater leaving the deaerator.

* Union Electric Co.

from a symposium on Deaeration held at the 1958 American Power Conference

Getting Good Deaeration

By H. A. GRABOWSKI*

TO BE TOTALLY effective, a deaerating method should be capable of removing oxygen over the range of loads anticipated in the operation of a boiler. It should be flexible enough to overcome temporary upsets and provide a good grade of water following a banked or start-up period. The deaerating method should be incorporated in the preboiler circuit design in such a way as to prevent a recontamination of deaerated condensate by heater drips or make-up water.

A partial answer to the question of efficiency of the two deaerating methods can be drawn from field studies completed by the writer's company with the coöperation of various utility organizations.

Our data indicate a need for increasing the range of operation of deaerating heaters and deaerating condensers to prevent the introduction of oxygen during low load, banked and start-up operation. A low potential for oxygen in a system is possible only when the deaerating method and the preboiler design of heaters and piping receive an equal measure of attention. Excellent results can be obtained with both deaerating heaters and deaerating condensers.

In the case of a deaerating condenser, attention should be focused on the following:

1. Prevent the addition of low-pressure heater drips into the condensate line downstream of the condenser.
2. Prevent the addition of undeaerated make-up into the condensate line.
3. Maintain oxygen removal efficiency at low loads.
4. Monitor the inleakage of air through piping downstream of the condenser.

A deaerating heater, when properly designed, assures a minimum of corrosion downstream of the heater. Attention should be given to the following when deaerating heaters are being applied:

1. Maintain a positive and constant deaerator pressure.
2. Size the heater to offset temporary upsets such as those following evaporator cracking periods.
3. Deaerate evaporator make-up water.
4. Direct low-pressure heater drips to the condenser at low operating loads.
5. Prevent the addition of undeaerated water to the condensate line upstream of the deaerator.

* Combustion Engineering, Inc

Watch That Condenser

By R. A. WILSON*

THE MODERN STEAM condenser has established itself as an excellent piece of deaerating equipment.

Under favorable operating conditions it is probably as good as any available deaerating equipment. It is only fair to point out, however, that condenser deaeration is performed under vacuum and that good results can be completely nullified by a small amount of air leakage into the deaerated condensate.

It seems certain that no one will get the best results out of pressure deaerating equipment without serious attention to the selection and erection of equipment and its operation.

There are reports of quick tests on condensers in systems which have deaerators, showing poor condenser performance. Generally such reports do not give any indication as to the performance that a condenser is capable of giving. In many cases the condenser is the "orphan" and is neglected.

We are not opposed to anyone installing a pressure deaerator if they prefer; but the condenser should still get careful consideration and be expected to give good deaeration performance.

Good condenser deaeration is much simpler to achieve than is generally thought by plant operators. Good deaeration has been demonstrated by hundreds of condensers of different manufacture and design under all sorts of operating conditions. Most all condensers are capable under reasonable circumstances of better performance than they were guaranteed to produce. This is reasonable and is to be expected.

It is felt that, where desirable, many plants can be built at a saving and operated with appreciable advantage, without deaerators, with comparatively little operating hazard. This does require a very realistic appraisal and perhaps a little more interest and alertness in design and operation than with the extra pressure deaerator.

The writer is associated with a department at Allis-Chalmers that makes both condensers and deaerators. We feel that both the deaerating condenser and the deaerator have had and will continue to have a place in the power field. The place of each of these in power plants will depend on careful evaluation in each case and the experiences and preferences of the users.

* Allis-Chalmers Mfg Co

Partially Closed System

By RALPH M. LEMEN*

THERE ARE THREE basic types of systems in which oxygen removal can be accomplished. One is the completely closed system with surface condenser hotwell deaeration. Another is the partially closed system with an open direct contact deaerator in the system serving as one of the stage heaters. The third is the completely open system where all of the stage heaters are direct contact heaters.

Advantages of an open deaerator in the system acting as a stage heater are as follows:

1. It provides for a large supply of deaerated water in the storage section which is readily available for gravity flow to the suction of the boiler feed pump.
2. It provides a receiver for heater drips and drains which are then deaerated. Also, this provides for increased thermal efficiency as compared to a closed system where closed heater drips are cascaded back to lower pressure heaters or to the condenser.
3. The open deaerator can receive several influent water streams at varying temperatures and quantities without affecting the oxygen residual in the effluent, whereas the total water introduced into a surface condenser shell at a temperature lower than the inlet steam temperature is limited to not more than 5 per cent of the steam being condensed.
4. An open deaerating heater performing as a stage heater heats the feedwater up to steam temperature as compared to approximately 5 F terminal difference with a closed heater in the system. Thus, the overall thermal efficiency of the system is increased by elimination of this terminal difference.
5. The open deaerator provides a means for removing oxygen and carbon dioxide from the vapor of the evaporator where an evaporator is used in the system.

A disadvantage often advanced against incorporating an open direct contact deaerator in a system is that it requires placing the unit high above the boiler feed pump to allow the necessary suction head, otherwise seizure of the boiler feed pump may occur as a result of flashing caused by sudden pressure loss in the deaerator. Anti-flash baffling is incorporated in the present-day deaerator design to help reduce this objection of flashing, and full suction head is provided on the pump.

* The Permutit Co

Timely review . . .

Are You Up-To-Date on BF Pump Warm-Up Methods?

By T. W. EDWARDS* and E. F. WRIGHT*

ABILITY of a stand-by boiler feed pump to protect a power plant adequately is a direct function of its ability to take over immediately upon failure of running equipment. This ability is more than mere automatic start-up provisions; the pump itself must also be ready. Of course, the suction and the discharge gate valve must be open and adequate lubrication provided for. In addition, the boiler feed pump should be uniformly warmed-up.

An article in POWER ENGINEERING of June, 1955 (Is Your Stand-By Boiler Feed Pump Warmed-Up and Ready to Run?) discussed various methods of adequately warming-up packed box boiler feed pumps. Let us review briefly these various methods:

First is the bleeding of drains in low pressure installations to produce a flow of hot boiler feed water into the pump or a jumper line with a throttle valve around the discharge gate and check valves.

Second is the substitution of a multiple pressure-reducing orifice for this throttle valve where higher pressure will not permit satisfactory life in a normal throttle valve (Fig. 1).

Third are the special arrangements for the utilization of balancing device leak-off flows where provided external to the pump, as shown in Fig. 2. This arrangement is not possible where opposed impeller designs of high pressure boiler feed pumps are involved, since stage leakage is broken down into several components and is contained wholly within the pump.

Let us now examine the operation of a boiler feed pump wherein condensate injection-type stuffing boxes are used. In Fig. 3, notice that the normal packed stuffing boxes have been replaced by a close-running, controlled-leakage joint. Cold condensate direct from the discharge of the condensate pump is injected at about the mid-point of this controlled-leakage joint at a pressure slightly in excess of boiler feed pump suction pressure. Therefore, a certain amount of this injection flow proceeds inward, ultimately joining the water being pumped. The remainder is broken down to atmospheric pressure external to the pump, and drained away through a trap to the condenser or, in some cases, to a miscellaneous drain tank.

Since stand-by boiler feed pumps are held ready to run, injection flow is left on in idle equipment. Hence, a

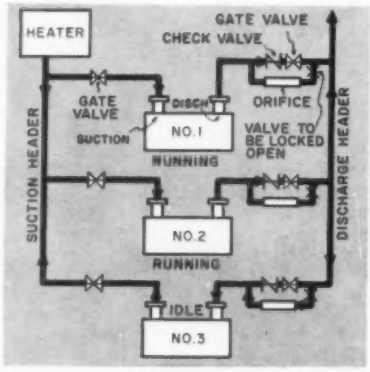


Fig. 1. High pressure warm-up, packed box, uses pressure-reducing orifice

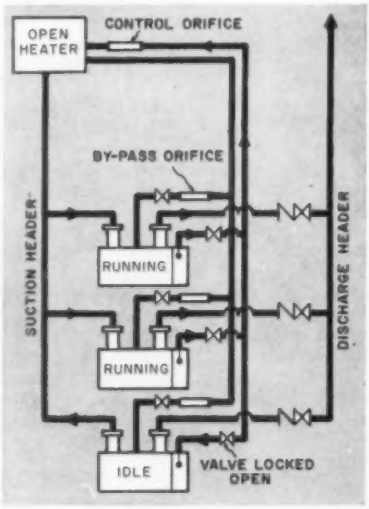


Fig. 2. Open-cycle special warm-up method using balancing device leak-off

certain amount of cold injection water is constantly bleeding into the idle boiler feed pump; and where reverse flow methods of warm-up are utilized, the amount of hot water recirculated must be increased to offset the cooling effect of the injection water. As a matter of fact, the utilization of a balancing device leak-off lines (as shown in Fig. 2) to effect boiler feed pump warm-up will not produce adequate flow and therefore cannot be used where condensate injection-type stuffing boxes are used.

At the suction end of high pressure barrel-type boiler feed pumps there is a pocket at the bottom of the barrel itself. (See Fig. 3, area A.) Since it is adjacent to the condensate injection-type stuffing box, this pocket is a natural place for the accumulation of cold condensate injection water which has been bled into the pump. It is so located that reverse flow, regardless of magnitude, cannot wash it out. In designs involving balancing devices, this problem is not as acute at the high pressure end of the pump since the size of the pocket is very small in comparison to the mass of the surrounding metal.

This pocket of cold water creates a special problem at the suction end. Wherever top suction nozzles are utilized, a drain connection is located in this pocket and can be used to drain away the cold injection water in an idle pump. This drain can either be manually or automatically controlled to conserve boiler feed water and perhaps interlocked with the controls for the main driving motor, since it need be open only when the pump is idle (see Fig. 4).

It should be noted that there is nothing wrong with having the drain on at all times since the rate of flow through it will not change, whether a pump is running or idle. However, since the drain flow serves no useful purpose during operation it becomes a loss and something to be guarded against in modern central station practice. Pumps having downward suction nozzles do not have this problem since the cold water will not collect but flow out of the pump without special provision.

The by-pass around discharge gate and check valve can be omitted if the high pressure portion of the barrel itself is drained as shown in Fig. 5. This latter drain should be located adjacent to the internal pressure joint and, of course, must be provided with a snap-action valve which can be interlocked with the driver so that it closes immediately upon start-up. In this regard, the high pressure drain differs radically from the low pressure drain mentioned above, which can be left on at all times if desired.

High-speed boiler feed pumps are normally provided with condensate injection-type stuffing boxes regardless of the cycle in which they are used. At speeds of 5000 to 10,000 rpm, the rubbing speed in stuffing boxes is too high to permit satisfac-

*Both of the Worthington Corp. Mr. Edwards is manager of the boiler feed pump section of Harrison Pump Dept. Mr. Wright is chief engineer of the centrifugal pump department, Harrison Division

tory packing life. The above procedures are therefore correct for any high-speed pump involving condensate injection stuffing boxes wherever a hot water booster pump is not involved. This would be the case in a closed cycle where adequate NPSH is made available by the condensate or cold water booster pump.

On the other hand, where hot water booster pumps are used to provide adequate NPSH such as in an open cycle and to protect the high-speed boiler feed pumps against transient operating conditions, a modification of this arrangement is possible. Since each high-speed boiler feed pump is provided with its own booster pump directly in series with it, reverse flow provided to warm-up the high-speed boiler feed pump also flows through the booster pump, thereby keeping it warm as well.

As shown in Fig. 6, the suction end drains of the high-speed boiler feed pumps can merely be interconnected with isolation valves only. The suction pressure of the running high-speed boiler feed pump will obviously be higher than the suction pressure of the idle high-speed boiler feed pump, since its booster pump is idle as well. Therefore, flow will occur through the interconnecting line into the suction cavity of the idle high-speed pump producing the same effect as the drain previously mentioned in connection with low-speed boiler feed pumps, i.e., the dissipation of collected cold water.

Another alternate arrangement which eliminates the high pressure snap-action valve and also eliminates the jumper line around the discharge gate and check valve is the interconnection of the high pressure drains. Since pressures in this zone change radically when a pump is running as opposed to when it is idle, it is necessary to introduce an orifice in the line. See Fig. 7.

All of these provisions for maintaining stand-by boiler feed pumps adequately warmed-up have but one purpose in mind — keeping them ready for immediate start-up upon failure of running equipment. While it is usually uneconomical to warm a boiler feed pump fully to operating temperature, since this would require a very high flow to produce an input of heat equal to the radiation losses, it is economical and desirable to maintain a boiler feed pump at a *uniform* temperature as close as possible to operating temperature.

The word *uniform* cannot be overemphasized. Insufficient warm-up flow will tend to produce a stratification of water and metal temperatures within the pump. Bottom of the pump will be considerably colder than the top of the pump and the distortion thus produced can nullify the effectiveness of stand-by equipment by making it impossible to start it up quickly. If the boiler feed pump under such conditions is distorted to the point where internal contact occurs, it can be severely damaged if efforts are made to start it, and might as well not have been provided at all.

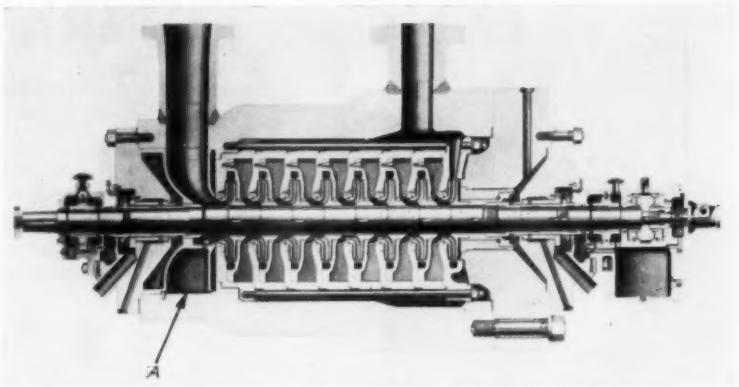


Fig. 3. Pump with condensate injection-type stuffing boxes. Pocket A, adjacent to box, accumulates cold condensate injection water which is bled into pump

While some boiler feed pump designs are capable of emergency cold starts, this should never be planned procedure. A similar case is your automobile which, in an emergency, can be driven cold at extremely high speeds. However, this should never be made a normal practice, if long satisfactory life is to be realized. Just so, adequate provision for boiler feed pump warm-up should be made available and used. Proper boiler feed pump warm-up procedures are an integral part of power plant reliability and each installation must be examined critically to determine the adequacy of the warm-up arrangement and procedures. THE END

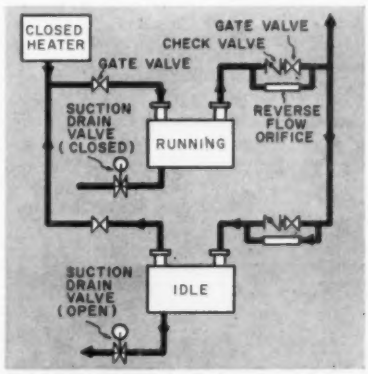


Fig. 4. High pressure warm-up arrangement (condensate injection-type boxes)

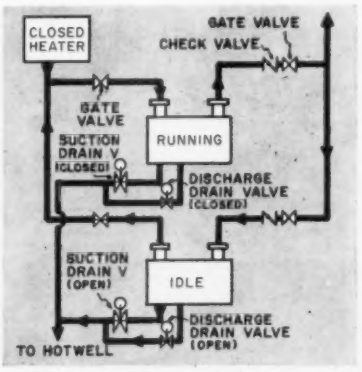


Fig. 5. Gate and valve by-pass can be omitted when h-p barrel is drained

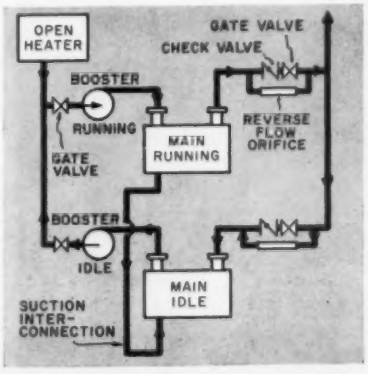


Fig. 6. High pressure warm-up arrangement (high speed with booster pump)

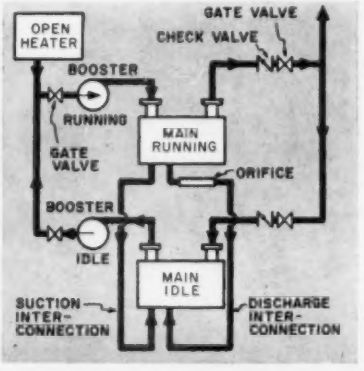


Fig. 7. This scheme eliminates h-p snap-action valve and jumper line

OPERATION SKYLIFT

Remodels 50-Cycle Plant

Out with the old, in with the new—and all through a hole in the roof! Here's how a contractor beat a stiff 110-day schedule by 47 days, and the story of an interesting, most unusual power plant alteration. This is an exciting article with a whirlwind finish

Fig. 1. Removing a steam drum of No. 1 boiler, up through the roof. Each boiler had three such, plus two mud drums

By SANFORD BLUE*

RIVERSIDE CEMENT Co, a division of the American Cement Corp, came to us with their problem: High operating costs at their Crestmore power plant.

Crestmore Plant of Riverside Cement has always operated on 50-cycle power. Since this frequency is no longer readily available commercially, they generate power with their own facilities.

Riverside's power plant consisted of four waste-heat boilers, each rated at 30,000 lb per hr of 200-psig, 525-F steam, and a gas-oil-fired boiler rated 80,000 lb per hr of 200-psig, 425-F steam, and three turbine generators.

Two of the turbine generators were steel-case units built by General Electric in 1925, and rated 3000 kw, 0.8 pf, 2400 volts, 3 phase, 50 cycle, 3000 rpm each. The other unit, with a cast-iron case, was built by Westinghouse in 1912, and rated 5000 kva, 2400 volts, 3 phase, 60 cycle, 3600 rpm, but operated at 3000 rpm to generate a maximum of 4000 kw at 50 cycles.

Turbines of all three units were designed for throttle conditions of 190 psig, 477 F. All boilers and turbine-generator units were connected to a common main steam header.

Operation of the waste-heat boilers at full capacity was undesirable because of excessive fan blade erosion from dust in the waste-heat gases. In order to meet the 10,000-kw demand, the fuel-fired boiler was operated at full capacity continuously with the four waste-heat boilers.

Preliminary investigation indicated that the waste heat from the cement kilns was sufficient to generate all their power needs without the costly operation of the fuel-fired boiler.

Any expenditure to reduce operating costs of the power plant had to show a definite payout in five years, or less. To do this, as much of the existing equipment must be used as practical, and any new equipment must fit the existing foundations and space limitations.

After considerable economic study, steam conditions of 650 psig, 825 F were selected and a new turbine-generator unit, with 200-psig, 625-F automatic extraction, was purchased to replace the older unit. The new turbine serves as a topping unit to supply steam to the remaining units. With this new heat cycle the over-all steam requirement was reduced approximately 15 per cent.

Higher temperature of the extraction steam to the turbines made it necessary to rework those turbines.

Other new equipment consisted of three waste-heat boilers, induced-draft fans, and two boiler-feedwater pumps, to replace old units. One of the old waste-heat boilers and the fuel boiler were kept for standby. The 240,000 lb per hr of 1450 F waste-heat gas available to each boiler contained 995 lb of fine dust so abrasive that it was impractical to operate the induced-draft fans with a tip speed greater than 11,500 ft per min.

Every industrial power plant installation requires special design features that are unique to that plant. This is especially true for revamp

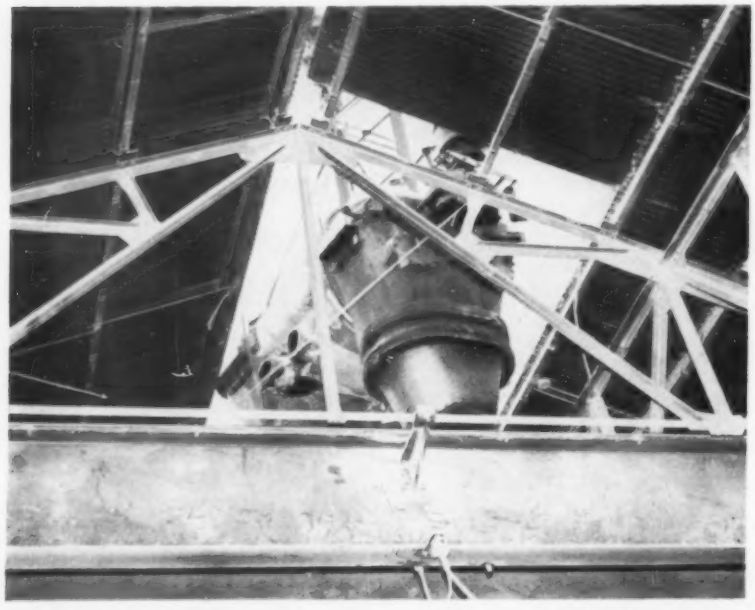


Fig. 2. Old turbine goes up and out. Crane operator was instructed by telephone

*Project Manager, The Fluor Corp, Ltd

jobs. A brief description of the major equipment items follows, highlighting some of the special features incorporated in the design.

New turbine-generator was supplied by Westinghouse to replace the old cast-iron, vintage 1912, unit. The turbine rating is 3500/4375 kw with throttle conditions of 650 psig, 825 F, and the generator rating is 4000 kw, 2400 volts, 0.8 pf, 3 phase, 50 cycle, 3000 rpm. The unit was designed to operate at 4160 volts, 60 cycles, 3600 rpm. By providing a high flux density generator, it can be operated satisfactorily at 50 cycles.

Turbine has a controlled induction-extraction opening for automatically extracting 200-psig, 625-F steam, or for inducting 200-psig steam from the fuel-fired boiler for start-up, if necessary. There is also an uncontrolled opening for bleeding steam to a 5-psig steam header for boiler-feedwater heating.

Upgrading Turbines

Throttle conditions of 120,000 lb per hr of 650-psig, 825-F steam will furnish 105,000 lb per hr of 200-psig, 625-F extraction steam. Because only a small amount of steam is required for cooling the last stages of the turbine, the existing surface condenser was more than adequate. By using an automatic-extraction turbine, the heat load on the existing spray pond was reduced approximately 40 per cent.

Extracted steam is used as the steam supply for the two existing units. Checking the original design specifications with the General Electric factory indicated that only the buckets of the first two stages had to be replaced for the turbines to operate satisfactorily at the increased temperature of 625 F.

In the event the new turbine-generator is shut down or does not supply sufficient quantities of extraction steam, a new pressure-reducing and desuperheating station will automatically reduce 650-psig, 825-F steam to 200 psig, 625 F to drive the G-E units. The 200-psig steam header can also be supplied with 200-psig steam at 525 F or 425 F from the old waste-heat boiler or fuel-fired boiler, respectively.

New Waste-Heat Boilers

Each of the new waste-heat boilers, supplied by Combustion Engineering, is rated at 42,000 lb per hr, 650 psig, 825 F, when supplied with 240,000 lb per hr of waste gases entering the boiler at 1450 F and leaving at 610 F, and with 215 F boiler feedwater.

Because of the dust concentration a specially-designed automatic sequential soot blowing system was installed. The soot blowers use 650-psig steam for maximum cleaning efficiency.

With limited control of the waste-heat gases from the kilns, it was necessary to install a pressure-control valve on the main steam header to relieve any excess steam to the atmosphere. This also made it necessary to have an elaborate alarm and control system on the boiler feedwater.

Two new 100 per cent capacity Byron Jackson boiler feed pumps were installed for the three boilers. Two of the existing boiler feed pumps were retained as standby to serve the fuel-fired boiler and the remaining low-pressure waste-heat boiler. The new pumps are rated 310 gpm, 1985 ft tdh, 202 bhp at 3650 rpm. The pumps are driven by Terry turbines operating on 650-psig, 825-F steam, exhausting into the 5-psig steam system.

For start-up, the Terry turbines can be operated on 200-psig steam from the fuel-fired boiler. The new pumps were supplied with turbines because of an excess of high-pressure steam and at no time was a complete plant shutdown contemplated.

Outlet of each boiler was directly connected to a new induced-draft fan. Each of the three new fans, supplied by American Blower, is capable of handling 240,000 lb per hr, or 107,000 cfm of 610-F gas at 3.7-in. static pressure and turning at 445 rpm with a tip speed of 11,500 fpm. The fans were directly connected to existing 225-hp, 12-pole, 50-cycle, slip-ring motors which have a speed range of 485 to 290 rpm. The fans are single-inlet type with special rimless wheels and bolted blades. The fan housings have ¼-in. replaceable wear plates inside the scroll.

No Shutdown Allowed

It was not desirable to shut the plant down during the construction. In fact, Riverside wanted to keep at least two turbine-generators in continuous operation at maximum capacity because any loss in kw generation meant a reduction of cement production.

Because of a cement shortage in the area, Riverside was anxious to expedite the "loss of generation" phase of the construction work. Our contract called for all work that would result in any loss of generation to be completed within 110 consecutive days, and not more than one turbine generator could be down at a time.

By isolating sections of the 200-

About the Author

Sanford "Sandy" Blue joined Fluor in 1946 as a draftsman. Seven years later, in 1953, he became project manager on a 50,000-kw addition to the Lawrence, Kansas, properties of the Kansas Power and Light Co. He later became project manager of the Crestmore job for Riverside Cement, described in this article.

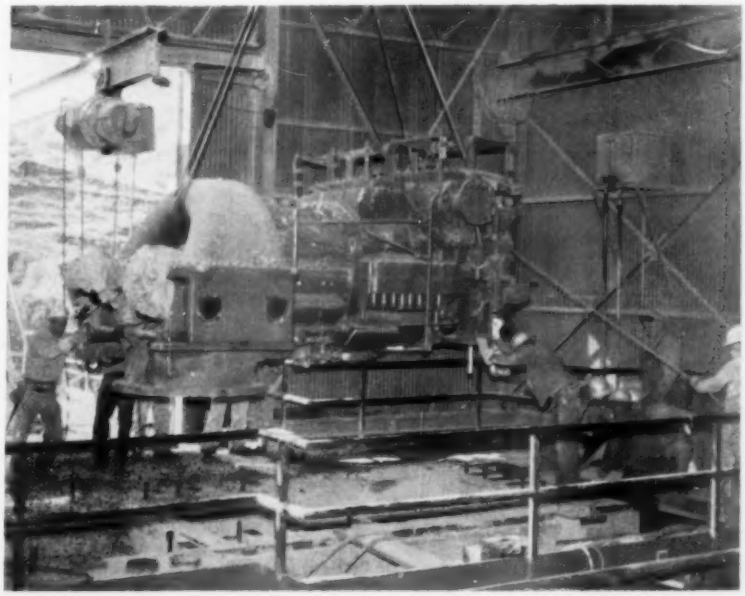


Fig. 3. New turbine is set on recapped foundation. 37 days after shutdown it ran

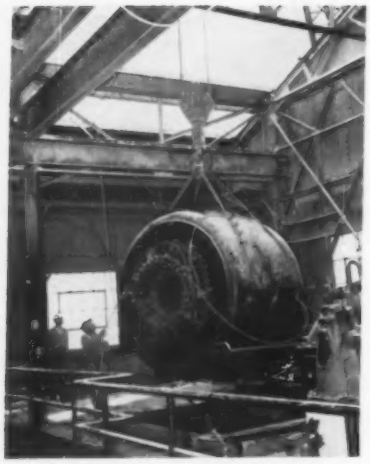


Fig. 4. Twenty-three tons of old (1912) stator start up, watched by the author

Fig. 5. High above the plant, the generator is guided safely toward ground

Fig. 6. Setting the new induced-draft fan for No. 1 boiler. Note phone in use

psig steam loop header, a schedule was developed whereby the work on the turbine-generators could be completed one at a time while the first boiler was being erected.

The only grade-level access to the power plant was from the west end, whereas the first new waste-heat boiler had to be installed in the east end. The west end contained the fuel-fired boiler and the old Westinghouse turbine generator.

Fan deck and turbine deck were ten feet above grade. Dust hoppers under the boilers extended down to screw conveyors located at grade. This made the task of moving boiler materials from the west end of the power plant to the east end via any passageway at grade impractical and uneconomical.

So, *Operation Skylift* was born. A hole was cut in the roof over the first boiler and another over the Westinghouse turbine-generator. The units were shut down and the race against time was on.

A detailed construction schedule that had been prepared earlier indicated the sequence of installation for each piece of equipment, valve, fittings, etc, to get maximum use and coördination of the construction facilities and personnel.

The boiler demolition work was performed in two shifts. The day shift demolished and the night shift removed the rubble of steel, tubes, and brick. All the rubble was loaded into buckets and hoisted out the hole in the roof by crane.

Rain!

Riverside had scheduled the shutdown to coincide with their normal rainy period because the demand for cement is lower during this period. Sure enough, it rained for four of the first five days of shutdown!

Seven days after shutdown we had removed the low-pressure boiler and had started erecting the structural-steel columns for the new boiler.

Eight days after shutdown we had removed the old turbine generator and poured a new top on the existing foundation to fit the new turbine generator.

Thirty-seven days after shutdown we started the new turbine generator.

And so went the race against time until, 63 days after shutdown, the first boiler was put into continuous operation. The new fan was operating. The new boiler feed pumps were operating. The existing two turbine generators had been reworked and all three units were now operating.

All this work was accomplished while maintaining a minimum kw load of 6,500. The race had been won — 47 days ahead of a 110-day schedule!

With one new boiler, two of the three remaining low-pressure boilers and the fuel-fired boiler operating, sufficient steam could be produced to operate the turbine generators at 10,000 kw total. Therefore, the other two boilers could be erected one at a time on a normal, non-accelerated basis, and the fuel-fired boiler eventually shut down.

Challenges and results like these make a person proud to be an engineer and proud to be a part of *Operation Skylift*. But it takes maximum coördination and coöperation between office and field, contractor and customer, supervision and every member of the field forces to achieve a record of accomplishment such as *Operation Skylift*. THE END

Outdoor Metal-Clad Switchgear Made Weather-Proof

AN OUTDOOR metal-clad switchgear unit that practically makes the maintenance man immune to the weather is news from Westinghouse.

The newly developed facility affords protection for scheduled maintenance, independent of the weather, and provides an opportunity for emergency operation, uncomplicated by snow or rain. This eliminates the one major handicap of conventional outdoor switchgear.

The switchgear is identical with indoor switchgear, except that it is placed in a weather-proof enclosure. The outer panel of the operating aisle is assembled across the front of the gear, the foundation channels are placed under it and the equipment is ready for shipment. The ends of the operating aisle, including the doors, are prefabricated and shipped separately. The floor plates and aisle roof section are manufactured on a per unit basis and shipped separately.

The enclosure is assembled in the field. The unit has space heaters, ventilation louvers, filters, interior illumination and a "crash" mechanism that will release the doors from the inside even if they are padlocked on the inside.

Westinghouse calls the new equipment "Shelterfor-M metal-clad," and points out that the sheltered area is not only adequate for operation but also has sufficient space to exercise the advantages of metal-clad switchgear, including the interchange and maintenance of circuit breakers. These improvements may be obtained at no loss in over-all plot plan area. When double bus, common aisle assemblies can be used, the ultimate in flexibility is obtained at the optimum in plot area use.

CONSTRUCTION NEWS

San Diego, Calif. — General Atomic Division of General Dynamics Corp, and eight Rocky Mountain and Pacific States utilities have announced the formation of a new research study program, directed toward the development of economically competitive nuclear power. Companies will form Rocky Mountain-Pacific Nuclear Research Group with plans to appropriate $500,000 for the study over a two-year period, which will be directed to high temperature, gas cooled reactors and possibility for direct conversion of heat into electricity. Arizona Public Service Co, California Electric Power Co, Pacific Power & Light Co, and Portland Electric Co will be associated with the new venture.

Miami, Fla. — Miami Baptist Hospital, Inc, 500 NE First St, has announced plans for the construction of a large hospital unit on property recently acquired at North Kendall Dr and SW 88th Ave. Work on the multi-storied facility will get under way in the fall of 1958 for completion by early 1960. Plans include the installation of a large steam power house and boiler facilities including laundry and food facilities. Unit is reported to cost in excess of $3,000,000.

Lemont, Ill. — The Atomic Energy Commission, Washington, D. C., has plans under consideration for the construction of a large new accelerator at Argonne National Laboratory, on large site selected for the purpose here. Work will include erection of a large particle accelerator housed in a 200-ft earth tunnel, 10 laboratory and auxiliary buildings, and utilities. Project will be a 12.5-billion, electron volt zero Gradient portion synchrotron, reported to cost in excess of $27,000,000. Sverdup & Parcel, Inc, St. Louis, Mo., are architects and engineers of the new facility.

Davenport, Iowa — Iowa-Illinois Gas & Electric Co, and Iowa Power & Light Co, Des Moines, Iowa, have announced jointly that they have plans under consideration for merging the two utility companies into one. Preliminary studies indicate that the proposed consolidation would in part offset increasing upward trend in costs in serving about 270,000 electric and gas customers. The electric systems of the two companies are already interconnected by existing transmission lines serving the two companies' customers, most of which are located in Iowa. Stone & Webster Service Corp, New York, N. Y., have been engaged to study the feasibility and economy of proposed consolidation.

Louisville, Ky. — Louisville Gas & Electric Co, 311 W Chestnut St, has authorized plans for major expansion of steam-electric generating plant here. Work will include installation of new 125,000-kw coal fired, steam generating unit, high pressure boilers and auxiliary equipment. Cost of new installation reported to be in excess of $20,000,000. Pioneer Service & Engineering Co, Chicago, Ill., are consulting engineers of the project, which is scheduled to be placed on line early in 1960.

Minneapolis, Minn. — Northern States Power Co, 15 S Fifth St, has work under way on construction of $25,000,000 addition to company's Black Dog Generating Station on the Minnesota River, south of Twin Cities. Plans call for the installation of a new steam-electric generating unit with an initial capacity of 150,000 kw, high pressure boilers and auxiliary equipment. Pioneer Service & Engineering Co, Chicago, Ill., are consulting engineers of the project.

Billings, Mont. — Carter Oil Co, 2813 Eighth Ave, North Billings, has announced that work is already under way on the renewal of existing equipment, including expansion and addition to company's boiler and furnace installation, to boost refinery capacity from present 25,000-bbl per day to 34,000 bbl daily. Work will be done at an estimated cost of about $1,600,000.

Hallam, Neb. — The Atomic Energy Commission, Washington, D. C., has authorized Bechtel Corp, San Francisco, Calif., to act as architects and engineers for construction of a new 75,000-kw nuclear power plant, to be operated by the Consumers Public Power District of Nebraska, 1452 25th Ave, Columbia, Neb. Project will consist of a sodium graphite reactor feeding steam to conventional turbine-generator equipment. Reactor portion of plant will cost $29,000,000, of which Consumers will provide $5,200,000, along with the plant site and construction of the turbo-generator. Construction will get under way at once for completion in early 1962.

Manasquan, N. J. — Borough of Manasquan, Sewer & Water Dept, has plans under consideration for the installation of a 150-kw a-c diesel-electric generating plant. New installation will be made to provide standby electric power for the Manasquan Water plant, in case of failure of main power supply. Work will get under way soon and the plant is scheduled for completion by early 1959.

Newark, N. J. — Public Service Electric & Gas Co, 80 Park Pl, has announced the contract award to the General Electric Co for a 320,000-kw cross-compound steam turbine-generator. This installation is the same or identical to the 320,000-kw machine ordered by the company last year. The two units, largest ever built for the company's system, will be installed in the new Mercer Generating Station now under construction on the Delaware River, below Trenton, N. J. Delivery for the first unit is scheduled for late next year and the second about the middle of 1960. New generating station, when completed in 1961 will cost approximately $130,000,000.

Buffalo, N. Y. — Board of Supervisors, Erie County, County Hall, Buffalo, will proceed at once with installation of new emergency power generator at Buffalo Children's Hospital, 219 Bryant Street. Preliminary engineering work is already under way and installation is scheduled for completion in early 1959. Cost of complete project reported to be about $130,000.

Beverly, Ohio — Ohio Power Co, 301 Cleveland Ave, SW, Canton, Ohio, a subsidiary company of the American Electric Power System has announced that it has placed in line a new 225,000-kw steam-electric generating unit at company's Muskingum River plant, here. New installation will give American Electric Power system's largest power station a total capacity of 1,105,000 kw. Plant was completed at a cost of $28,000,000.

Hamilton, Ohio — City of Hamilton, Municipal Utilities Dept, has announced plans for the construction of new building to house new generator and extensions and improvements in municipal power system. Cost reported to be about $636,600. Vaughn Building Co, Hamilton, Ohio, has been awarded the construction contract. Work is expected to get under way at once.

Nanticoke, Penna. — Luzerne County Gas & Electric Co, 247 Wyoming Ave, Kingston, Penna., has plans under way for the design and construction of new addition to company's Hunlock Creek Power Plant, here. Work will include installation of turbine generator unit, high-pressure boilers and accessory equipment for increased capacity. United Engineers & Constructors, Inc, Philadelphia, Pa., has been awarded the construction contract. Work on foundations is already under way and new addition when completed in 1960 will represent an estimated cost of between $10,000,000 and $15,000,000.

White Salmon, Wash. — Klickitat County Public Utility District of Washington has plans under consideration and has applied to the FPC for a preliminary permit to investigate the hydroelectric power possibilities of the White Salmon River, a tributary of the Columbia River in south central Washington. Company proposes to build two storage dams in the upper river basin to store 83,000 acre ft of water for a series of five downstream powerhouses and a single powerhouse between the two reservoirs. The six powerhouses would range in capacity from 13,000 to 48,000 kw to develop 625,000,000 kwh of firm power energy annually in a minimum water year. Estimated total cost of proposed development $48,500,000.

Eau Claire, Wis. — Northern States Power Co of Wisconsin, 4 S Barstow St, subsidiary of Northern States Power Co of Minnesota, has plans under consideration for the rebuilding of transmission lines between Oak Park and Wissota. Installation of 35-mile 115-kv transmission line between these points will cost a reported $305,000. Work is scheduled to get under way the early part of 1959.

Power Engineering handbook

How to Estimate Flow of Water Through Open-Ended Pipes

BY JOHN D. CONSTANCE

QUITE OFTEN in plant operating practice we are called upon to estimate water discharge rates of streams issuing from apertures such as fire hydrants, sludge lines, and mere open-ended pipes. The flow from deep wells may similarly be estimated when flow-measuring instruments are not available. All that is required is a folding rule or tape, plumb line and spirit level. But let's first examine the basic theory.

Path of a Jet

When a jet of water or any other liquid having the characteristics of water (negligible viscosity) issues from an aperture whose axis is horizontal, its direction of flow is at first horizontal, but the force of gravity immediately causes the jet to move in a curve which will be shown to be the common parabola.

Let x be the abscissa and y the ordinate of any point of the jet path shown in Fig. 1. Effect of the impulse due to the hydrostatic head h is to cause the space x to be described uniformly in a certain time t; or, if v is the velocity of flow, $x = v\,t$. Effect of the force of gravity is to cause the space y to be described in accordance with the laws of freely falling bodies, i. e., $y = \frac{1}{2}\,g\,t^2$, where g is the gravitational constant (32.2 fps²). Eliminating t from these two equations and

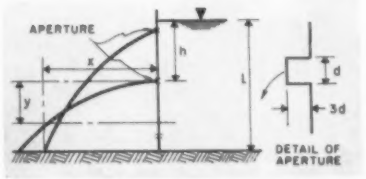


Fig. 1. X is the abscissa, y the ordinate of any point on this jet path. Vessel height is designated by L

replacing v^2 by its theoretical value $2g\,h$,

$$y \times g\,x^2/2v^2 = x^2/4h \qquad (1)$$

which is the equation of a parabola whose axis is vertical and whose vortex is at the aperture.

Horizontal range of the jet for any ordinate y is found from Eq. 1. If the height of the vessel is L, the horizontal range on the plane of the base is

$$x = 2\sqrt{(h)\,(L-h)} \qquad (2)$$

This value of x becomes zero when h is zero, and also when $h = L$. The value of x becomes a maximum when $h = \frac{1}{2}L$. Thus, the greatest range for the system in Fig. 1 is at mid-height of vessel.

In practice the above equations are modified by the frictional resistance of the edges of the aperture (orifice) which renders the value of v less than the theoretical, this being $\sqrt{2gh}$. Theoretically, the time t required to hit the ground outside is the same as that required to reach the same vertical distance. Air resistance also reduces the value of v. However, in practice, the above equations may be used to estimate flow within acceptable limits of plant accuracy. Take two examples:

Example 1

Flow in a city water system is being tested by allowing the flow of water from a hydrant with an outlet 4 in. in diameter. The center of the outlet is 2 ft above the ground level and the issuing jet strikes the ground at a horizontal distance of 9 ft from the outlet. How many gpm are flowing from the outlet?

Solution: Refer to Fig. 2. The issuing stream fills the entire cross-section of the outlet. From Eq. 1 and by rearrangement

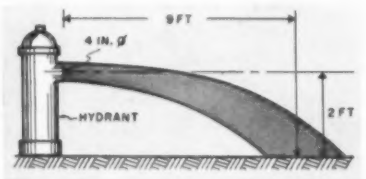


Fig. 2. Issuing stream fills the entire cross-section of the outlet. Equation 1 is used to find the answer

$$v = \sqrt{\frac{x^2 g}{2y}},\ \text{fps} \qquad (3)$$

Then by substituting the proper values of x and y from Fig. 2

$$v = \sqrt{\frac{9^2 \times 32.2}{2 \times 2}} = 25.6 \text{ fps flow velocity.}$$

From the Law of Continuity

$$Q = A\,v,\ \text{cfs} \qquad (4)$$

where A is cross-sectional area of outlet

$$Q = 0.7854 \times \frac{4^2}{12^2} \times 25.6 = 2.24 \text{ cfs.}$$

This is the volume of water flowing per second through the hydrant outlet. Or

$$\text{Gpm} = \text{cfs} \times 60 \times \text{gal per cu ft}$$

Or

$$\text{Gpm} = 2.24 \times 60 \times 7.5 = \textit{1004} \text{ gpm. Ans.}$$

Example 2

In a filling operation a dredge is pumping sand, water and mud through a steel pipe 12 in. in diameter. The discharge pipe is supported horizontally 4 ft above the ground. If the center of the jet from the pipe strikes the ground at a distance 4 ft away from the center end of the pipe horizontally, how many cubic yards of mud, water and sand would be delivered by the pipe in two hours?

Solution: See Fig. 3. Here the mixture of sand, water and mud may be considered having the general characteristics of the water which is predominant. Now, substituting as in the previous problem

$$v = \sqrt{\frac{x^2 g}{2y}} = \sqrt{\frac{4^2 \times 32.2}{2 \times 4}}$$

$= 8.02$ fps at outlet

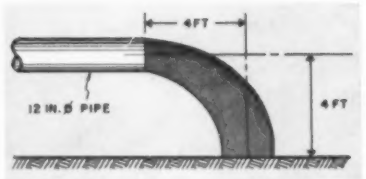


Fig. 3. In this example, how many gpm are flowing from outlet? For the answer, see Example 2

Then, $Q = Av = 0.7854 \times 12/12 \times 8.02 = 6.3$ cfs. By dimensional analysis

$$\frac{\text{cu ft}}{\text{sec}} \times \frac{\text{sec}}{\text{hr}} \times \text{hr} \times \text{cu yd/cu ft} = \text{cu yd}$$

Or, $6.3 \times 3600 \times 2 \times 1/27 = \textit{1680}$ cu yd. Ans.

Problems of this type follow the reasoning outlined above and should be readily recognized. It would prove practical to estimate flow in everyday operations in power and processing plants. By experimentally determining values for x and y for different conditions of liquid character and flow the above principles may readily be applied.

In the actual physical piping arrangement the jet must project horizontally and the exit pipe must be level. Another important consideration is to provide a straight run of pipe after any obstruction or elbow in the pipe system upstream of the aperture.

POWER ENGINEERING HANDBOOK

fold along this line—outside edges toward you

cut along this line

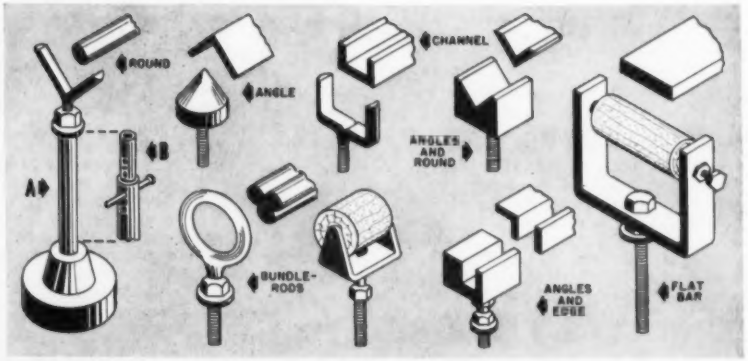


Fig. 1. These types of supports are useful for bars, flats, angles, rounds, to be used on pipe-stand shown at A, adjustable for height by using telescoping tube or pipe B, at any assembly job

Ideas for Your Notebook

By CHARLES H. WILLEY

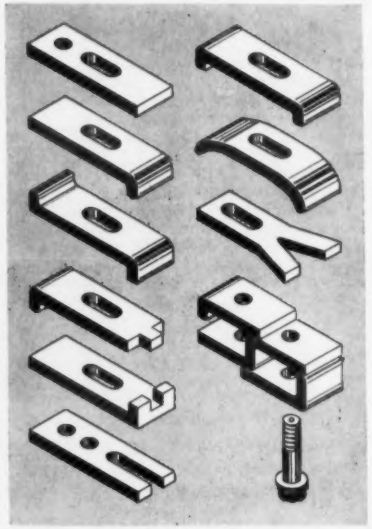


Fig. 2. Types of shop-made straps or hold-down clamps which can help to quickly secure set-up or holding of various jobs on beds of machine tools and assembly platens. Use machine steel

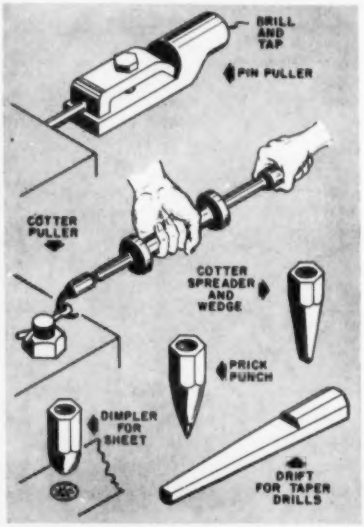


Fig. 3. Impact sliding hammer has many uses when made as shown here, and if you equip it with various attachments. Make them all of tool steel, to fit 9 length ⅜-in. drill rod threaded each end

Tapping Into Pipe Line

By E. L. FAUTH

SKETCH SHOWS METHOD for tapping into a pipe line (which is under pressure, or vacuum) by use of simple fittings which can be found in any plant.

Weld a standard pipe coupling onto the pipe line to be tapped.

Screw into this coupling a short length of pipe (2 in the sketch) and a gate valve, 3.

Construct an assembly of pipe 4, coupling 5, pipe bushings 6, brass washers 7, and packing 8.

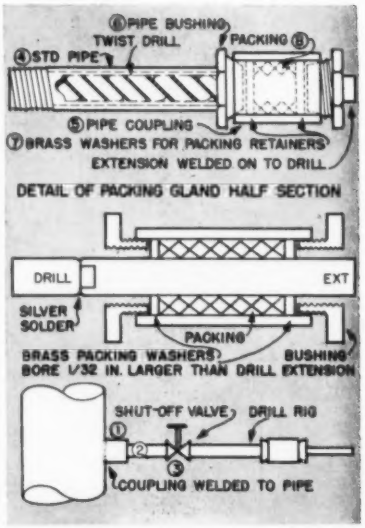
Silver-solder an extension onto a standard drill. Insert this through the assembly. Tighten the bushings to provide a packing gland around the drill.

Open the gate valve to full opening.

Drill hole through pipe being tapped.

Withdraw drill to a point where gate valve can be closed.

Remove entire drill rig; couple on branch pipe as required.



Using Dry Ice for Compound Removal

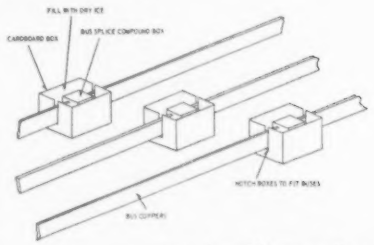
BY D. W. ALVERSON

DURING the past five years our company (Nekoosa-Edwards Paper Co) has been replacing 14.4 kv switchgear with Westinghouse 150 DH500 air circuit breakers. As with most industrials, the downtime is very difficult to get and changes must be made as fast as possible.

One of the most trying problems has been the problem of removal of the bus splice compound boxes and the compound. If a torch is used the compound becomes very sticky, produces a cloud of smoke and gas, making removal very difficult and time consuming.

To reduce the amount of downtime required, we have turned to the use of dry ice. The sketch describes how the ice was applied in cardboard boxes to the bus splice compound boxes. The time required for a good chill is approximately one hour, after which the box and compound can be chipped off the bus very quickly with a small hammer and chisel.

Normally, new compound boxes are furnished with the switchgear being added on, so breaking of the original box is of no consequence.



Westinghouse Maintenance News

Ice was applied in cardboard boxes to bus splice compound boxes. This sketch shows steps taken

Introduction to Steam Power

4—Units and Methods of Measurement

This is the fourth installment in the basic course on steam power fundamentals, developed by Commonwealth Edison Co and being serialized in the Handbook as an aid in the training of power plant operators everywhere. Covered so far—Introductory Aspects of Power Generation (May); Fuel Supply and Characteristics of Coal (June); Combustion (July). Next—Heat Transmission

Thermal Units

1. Temperature is a measure of the *intensity of heat* or the degree of hotness of a body.
   a. Fahrenheit scale — the American standard: This scale divides the difference between the temperature at which water freezes (32 F) and the temperature at which water boils (212 F), under a standard atmosphere of pressure, into 180 equal parts. For higher and lower temperature this scale is extended by this standard unit.
   b. Centigrade scale — used internationally in scientific work: This scale divides the difference in temperature of water at freezing point (0 C) and boiling point (100 C) into 100 equal parts. For higher and lower temperature this scale is extended by this standard unit.
   c. Absolute scale: This scale reckons from an absolute zero (approximately − 460 F), a point representing the absence of heat energy.
   d. Relationship between the temperature scales is shown by: $t_c = 5/9(t_c - 32)$; $t_f = 9/5t_c + 32$; tabs = $t_f + 460$. Chart in Figure 1 illustrates these relationships.
2. Specific heat
   a. Specific heat of any substance is the amount of heat required to raise the temperature of a unit weight of the substance one degree. Specific heat of a substance varies with temperature changes.
   b. Mean specific heat over a given temperature range is the average quantity of heat required to raise the temperature of a unit weight of the substance one degree of temperature. Mean specific heat of water (at standard atmospheric pressure) between 32 F and 212 F is one.
3. Heat quantities
   The British thermal unit (Btu) is a unit of measurement of *quantity of heat.*
   a. A Btu is 1/180 of the heat required to raise the temperature of one pound of water from 32 F to 212 F at standard atmospheric pressure.
   b. Generally expressed as Btu per lb of substance or as Btu per hour in heat transfer.
4. Relationship of the thermal units
   Total heat change (Btu) = mean specific heat × temperature change (F deg) × weight (lb).

Pressure

1. Terms and units used: a, pounds per square inch (psi); b, inches of mercury; c, inches of water.
2. These pressures may be stated as "gage" or "absolute."
   a. Gage pressure is reckoned from atmospheric pressure. 1. Atmospheric pressure varies geographically and with weather conditions. 2. Standard atmospheric pressure is considered as approximately 14.7 psi or 29.92 in. of mercury. 3. Pressures above atmospheric are considered positive and those below atmospheric are considered negative. 4. Gages must be corrected for water column head if elevation of gage is above or below point of measurement and if column is filled with water.
   b. Absolute pressure is reckoned from the condition where no pressure exists (perfect vacuum). 1. Barometer and absolute zero and readings are considered positive. 2. Vacuum gages reckon below atmospheric pressure.
   c. Figure 1 illustrates the relationship between gage pressure, absolute pressure and vacuum readings.
3. Conversion between units
   a. One inch mercury = 0.491 psi
   b. One inch mercury = 13.6 inches of water (at 62 F)
   c. One foot water (62 F) = 0.433 psi
   d. Absolute pressure (lb) = gage pressure + 14.7
   e. Absolute pressure (inches of mercury) = barometer reading — vacuum mercury column.

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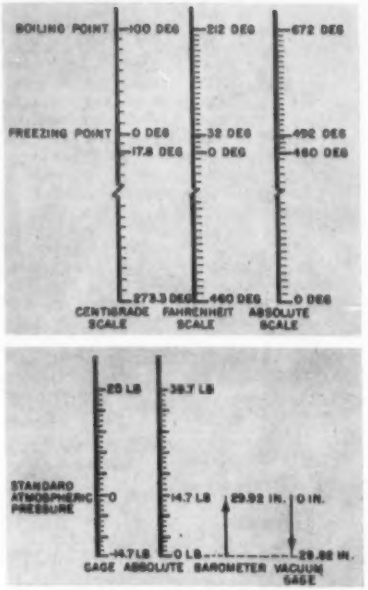


Fig. 1. Relationships between temperature scales, gage and absolute pressure, vacuum readings

Fluid Measurement

1. Fluid quantities may be expressed in units of weight or volume
   a. Density of a substance is commonly expressed in lb per cu ft.
   b. Density varies with temperature and pressure changes.
2. Common units of flow measurement
   a. Pounds per hr — steam and water flow.
   b. Cubic ft per min (cfm) — water and air flow.
   c. Gallons per min (gpm) — water flow.
3. Conversion between units
   a. One cu ft of water (at 62 F) = 62.355 lb.
   b. One cu ft = 7.48 U. S. gal.
   c. One gal. of water (at 62 F) = 8.33 lb.

Energy Units

1. Energy exists in many forms, such as heat, mechanical, electrical and chemical energy.
2. There is a definite relationship between the various forms of energy and it is *possible theoretically* to change from one form to another without loss.
3. Energy equivalents
   a. One horsepower hour = 2545 Btu.
   b. One kilowatthour = 3413 Btu.
   c. One horsepower-hour = 0.746 kilowatthour.

Instruments

1. Temperature measurements
   a. Pressure-actuated thermometers: 1. Expansion type. 2. Expansion of gas in a heated bulb moves a pointer on a sensitive bourdon gage. 3. Range — 40 F to 1000 F. 4. Sensitivity — usually low with considerable lag in most types.
   b. Mercury thermometers: 1. Expansion type. 2. Range — 35 F to 1000 F. 3. Sensitivity — very good if well made. 4. Extreme accuracy requires compensation for exposed part of mercury column.

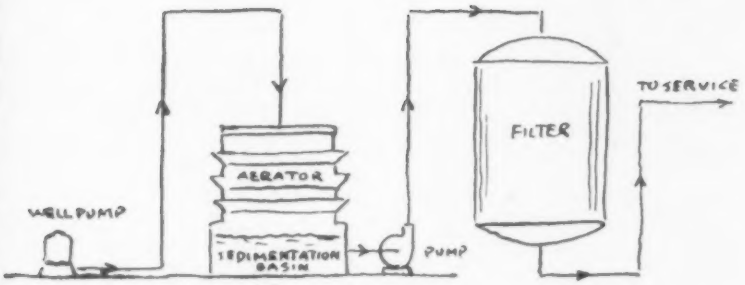
POWER ENGINEERING HANDBOOK

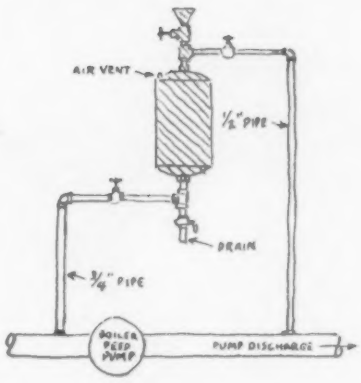
fold along this line—outside edges toward you

cut along this line

$$Ca^{++} + Na_2Z = CaZ + 2Na^{+}$$

347832
3.06
2086992
10434960
10643 65.92





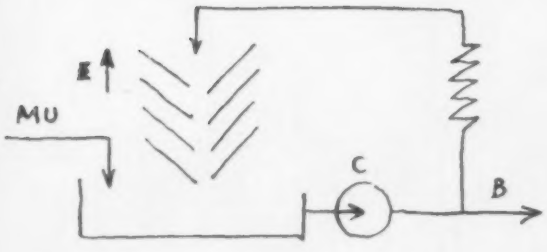
$$V = \frac{18.5D^2(S_1 - S_2)}{Z}$$

any way you figure it,

the best solution to your

water problems is . . .

$$\frac{x}{m} = KC^{1/n}$$



■ CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

BETZ LABORATORIES INC., Philadelphia 24, Pa.

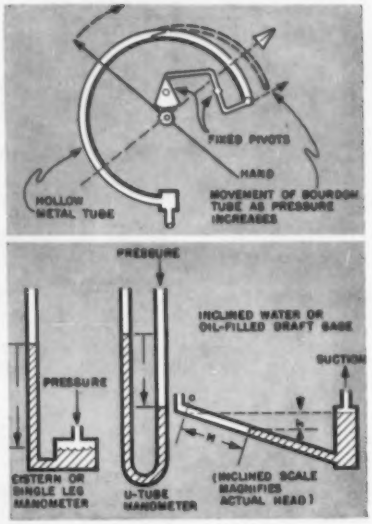


Fig. 2. Top figure is bourdon-type pressure gage for high pressures. Types in lower drawing are used for measuring low pressures. Two figures at left show mercury or water-filled manometers

c. Bimetallic elements: 1. Expansion type. 2. Magnifies movement resulting from unequal thermal expansion of two metals. 3. Sensitivity — moderate. 4. Adapted to thermostatic type of controls.

d. Thermocouples: 1. Two wires, of dissimilar metals, welded together at one end, will produce a voltage at the terminals when the welded point is heated. 2. This small voltage is proportional to temperature. 3. An accurate voltmeter (a potentiometer) is required to obtain accuracy. 4. Range — 32 F to 2900 F. 5. Sensitivity — very good depending on accuracy of measuring instruments. 6. Flexibility good — measuring instrument may be located at any distance from point being observed.

e. Optical pyrometers: 1. Utilizing the change in brightness of the light emitted by an incandescent body. 2. The current through the lamp is adjusted by means of a rheostat. 3. A means of measuring temperatures from 1100 F to temperature of the sun.

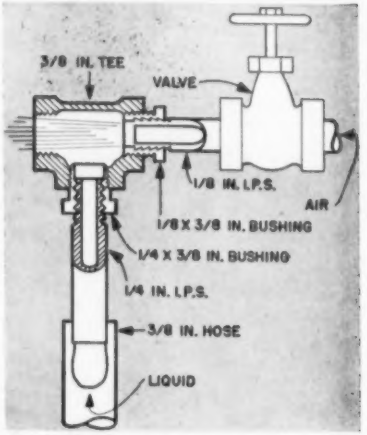
f. Radiation pyrometers: 1. This type depends on the heat radiated by hot bodies (visible plus invisible light rays). 2. In this method the rays of radiant heat are reflected and converged by means of a mirror upon a thermocouple. 3. Used for temperatures from 300 F to 4000 F.

2. Pressure-measuring instruments
   a. Bourdon-type gage for high pressures: 1. Hollow spring expanding moves an indicating needle or hand. 2. Pressures from 0 to 10,000 psig.
   b. Mercury manometers: 1. Very accurate for low pressures. 2. Pressures from 0 to 30-in. Hg or 0 to 15 psi.
   c. Water manometers: 1. Accurate for extremely low pressures — 1 to 200 in. of water. 2. Use of inclined type increases readability and accuracy.
   d. Oil-filled inclined draft gages: 1. For measurement of very low drafts — 0.01 to 1 in. of water.
3. Fluid measurement
   a. Includes measurement of quantities or rates of flow of steam, air, gas, water, and other liquids.
   b. Methods of measurement: 1. Volumetric or rotary meters. 2. Head or velocity meters. 3. Batch weighing or volume measurement.
   c. Volumetric or rotary meters: 1. Piston type — measures a definite volume per stroke. 2. Rotary vane type — vane rotates continually due to force of liquid flow. 3. All meters of this type subject to a certain slippage and not used for precise measurement.
   d. Head-type meters: 1. Pressure drop across a restriction placed in the pipe is transmitted to the measuring element. 2. Measuring element converts the pressure drop or "head" into a reading directly proportional to flow and records or indicates the flow. 3. Pressure drop or head is obtained by installing a device in the pipe line — orifices, flow nozzles, venturi tubes. 4. Meters of this type, well constructed, are very accurate except at the lowest part of their range. 5. Require considerable care in their use and periodic cleaning to maintain initial accuracy.
   e. Batch weighing and volume measurement: 1. By means of weigh tanks is the most accurate of all methods, requires sensitive scales, and weighing is intermittent. 2. Volume "batch" measurement uses volumetrically-calibrated tanks, temperature and density of liquid must be allowed for, and measurement is intermittent.

fold along this line—outside edges toward you

Jet Sprays Solvents on Motors in Place

By PAUL C. ZIEMKE



THIS SKETCH SHOWS a simple little device that has proved most handy on numerous occasions. I built the initial unit in a day when we had single armature Goodman locomotives.

The case resembled two bathtubs bolted together and laid parallel with the running gear. The joint could not be maintained water-tight when mining under the Montreal River, and we used the jet to keep the lower armature coil from "floating" in the oil-water emulsion. A drain plug was out of the question since we sometimes operated in 1 ft of water.

In addition to use for spraying solvents on motors and equipment in place, this aspirator is also used in the larger sizes for dewatering small tanks or other vessels lacking drain facilities, and for pumping Transil oil to elevated oil switches and transformers of smaller sizes.

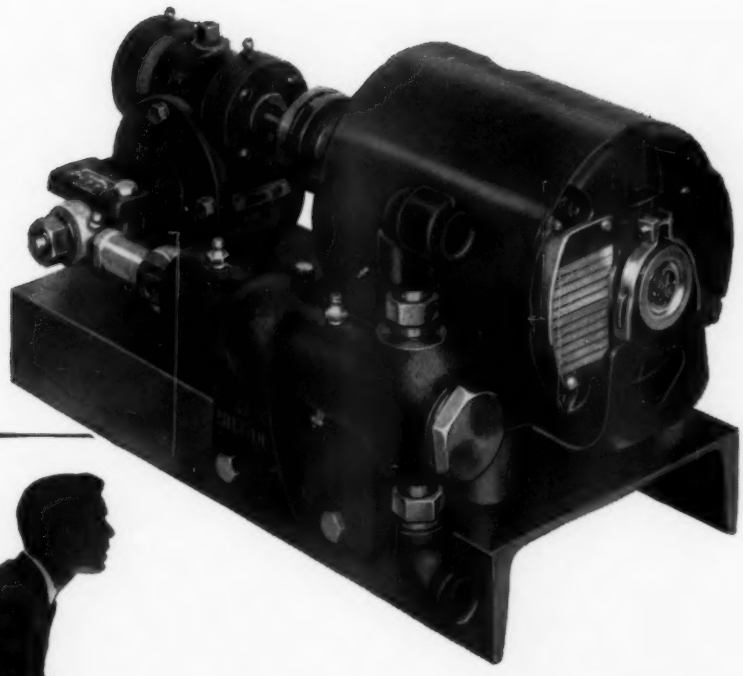
Steam Leaks Cost Money—and Here's How Much

HOW MUCH, is usually a matter of conjecture. But here's a table showing cost of various sized steam leaks at 100 lb pressure, and assuming that steam costs 50 cents per 1000 lb. It's from Armstrong Machine Works.

For steam at 50-lb pressure, waste is about 75 per cent of the table figure; at 20 lb, it is about 50 per cent; and at 5 lb, the loss is about 25 per cent. Many engineers today report steam costs considerably in excess of 50 cents per 1000 lb on which the table below is figured.

Size of Orifice	Lb Steam Wasted Per Month	Total Cost Per Month	Total Cost Per Year
½-in.	835,000	$417.50	$5010.00
⅜-in.	470,000	235.00	2820.00
¼-in.	210,000	105.00	1260.00
⅛-in.	52,500	26.25	315.00
1/16-in.	13,200	6.60	79.20
1/32-in.	3,400	1.70	20.40

cut along this line



Look again

At the Milton Roy H20® Controlled Volume Pump

Here's low-cost protection for your boilers . . . Milton Roy H20 controlled volume pumps have capacities ranging from 0.12 to 56 gph, for pressures up to 1100 psi. Both simplex and duplex models are available—for immediate delivery from stock—with stainless steel or cast iron liquid ends.

H20 pumps will give you accurate metering—efficiently and economically—of boiler-water treatment chemicals and other mildly corrosive and non-corrosive liquids. Depend on these pumps for long service life with a minimum of maintenance. And Milton Roy H20 pumps are available in complete packaged systems for boiler feed-water treatment . . . consisting of a steel tank, H20 pump, relief valve and suction piping.

Take a second look at these quality pumps . . . and always look to Milton Roy for assistance in the solution of your most difficult controlled volume pumping problems. Write for detailed information—Bulletin 557—Milton Roy Company, 1300 East Mermaid Lane, Philadelphia 18, Pa. Engineering representatives throughout the world.

Controlled Volume Pumps • Quantichem Analyzers
Chemical Feed Systems • Anders Air and Gas Dryers

milton Roy
CHEMICAL INSTRUMENTATION SYSTEMS

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EQUIPMENT NEWS

Described on these pages are new and improved products. Use Reader Service Cards on pages 127–128 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—CIRCUIT BREAKERS for high voltage power systems

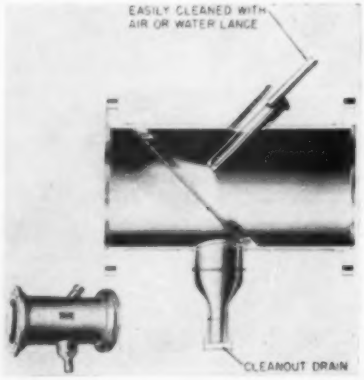
These outdoor air blast power circuit breakers are for high voltage electric power systems. The breaker design, for application on systems ranging from 115,000 v through 460,000 v, is based on a pressurized interrupter principle utilizing modular units to provide all required ratings. According to company, the basic design module permits a practical building block approach to the application of transmission power circuit breakers. Starting at 115 kv, 10,000 mva interrupting capacity, each added column increases the voltage and interrupting rating. Among advantages claimed are high speed interruption, ability to withstand maximum voltage recovery rate associated with transmission line faults, and less out-of-service time for routine inspection. General Electric Co.

2—ELECTRIC CHUCK eliminates manual chucking

The Electrimatic Chuck is offered as optional equipment on company's Model A or Speed-O-Matic pipe and bolt machines. With this chuck you merely flip the switch and the jaws instantly grip the pipe or rods. Range is ⅛ in. to 2 in. The chuck operates either forward or reverse. Wearing parts are hardened tool steel. Beaver Pipe Tools, Inc.

3—START-UP STRAINERS protect pumps in new piping

These large size, start-up strainers are designed to protect boiler feed, condensate and circulating pumps and other equipment installed in new piping construction. Available in 6- to 16-in. steel construction with 150- or 300-lb flanges, the strainers protect against dirt, mill scale, and other debris common to new piping systems. The "straight-through" pipe construction keeps pressure differential across the strainer to a minimum, it is noted, and the removable screen permits option of leaving the strainer body in the line permanently or removing strainer for re-use and replacing it with a spool piece. The screen may be cleaned by inserting an air, steam or water lance and flushing trapped debris down the cleanout drain. The latter is threaded for cap or gate valve, and the strainer may be installed horizontally or vertically. Manufacturer says this self-



cleaning feature reduces strainer cleaning time from the 4 hr required by many strainers to only 10 min. Leslie Co.

4—PNEUMATIC CONTROLLER is compact, low in cost

Primarily for temperature or pressure control, the USG Pilot is designed to provide not only two-position control but also wide band proportional, with or without automatic reset or rate action. Only 8½ in. square by 4 in. deep, the unit can be surface-mounted on equipment, or flush-mounted on instrument panelboards. It can also be mounted on the pneumatic-operated valve that it positions. Indication of measured variable (such as pressure) is made on a 3½-in. dial (6¾-in. scale length). A pointer also indicates the knob-adjusted set point on this dial.

Three modes of pneumatic control offered are: two-position with differential gap, adjustable from 1 to 100 per cent; proportional control, adjustable 1 to 100 per cent; and proportional control (1 to 150 per cent) plus automatic reset or rate action. Design permits change from one mode to another after unit is installed. U. S. Gauge Div., American Machine and Metals, Inc.

5—COATING affords protection against rust

Long-lasting rust prevention at lower cost is announced for Arrust, a fish oil penetrating coating fortified with a rust inhibitor. It is described as low in cost and easy to apply and suggested for use on all rusted or rustable metals. Manufacturer says it can be used directly over firm rusted surfaces without peeling or flaking, and acts as both a prime and finish coat. Except for severely rusted surfaces, only one coat is necessary. According to manufacturer, Arrust stops rust by penetrating and combining with oxidized material to form an impervious, elastic coating. It is also reported resistant to moisture, atmospheric conditions, acids, oils and most chemicals. It comes in red or black. A gallon covers about 300 to 400 sq ft. Arted Co.

6—D-C DRIVES feature static power conversion

Ultraflex Packaged Drives utilize light, compact static power components to replace the conventional motor generator set. Ultraflex conversion units eliminate bearings, brushes, commutators, shafts and couplings, manufacturer points out; compactness of the drive permits worthwhile savings in floor area required, and

reduction in weight permits wall-mounting of many sizes. Simplified circuitry in the conversion units facilitate installation and maintenance of the drives. These drives come in two forms: Ultraflex E, a 1 to 40 hp electronic adjustable speed drive; and Ultraflex M, a 1 to 200 hp magnetic amplifier adjustable speed drive. Both include three basic components: an enclosed panel, housing the conversion and control units; an operator's station; and an industrial d-c motor. The operator's station incorporates start-stop pushbuttons and a speed adjusting potentiometer or regulator. Cutler-Hammer Inc.

7—TREATMENT controls pH in recirculating systems

Buildup of slime, algae, corrosion and scale in air conditioning, humidifying and heat exchange equipment may be prevented with Airefiner 54, according to manufacturer. Used at concentrations of 2 to 4 lb per 1000 gal of water, Airefiner 54 is said to keep the pH of water in the low alkaline range, minimize delignification of wooden cooling towers and deposit of white coatings on equipment. Soluble in hot or cold water, the material is claimed not toxic in recommended solution and unaffected by heat. Oakite Products, Inc.

8—RECORDING ANNUNCIATOR pinpoints trouble

Pinpointing trouble and providing information for quick analysis of equipment failures is the dual function of this recording annunciator. Developed to provide a compact, permanent record of the off-normal and return-to-normal operations of power substation equipment, the unit has application where an

Crane Stop-Checks Mean Safer Boiler Operation

This valve cost-free for quarter century

Gate, globe, angle or stop-check—Crane steel valves are hard to beat for low-cost service on steam.

This is proved again on the installation at Scott Paper Company's West Coast Division at Everett, Wash. This Crane 300-pound stop-check has been on one of its boilers since the pulp mill was built in 1929. Working pressure: 250 psi at 450 deg. F.

Not until 1954 did this Crane No. 30XU valve need any repairs—after 25 years of steady operation with just routine maintenance. Now with new parts, it's ready to set another such record.

A single moving part: the disc—with chatter-free throttling lip—and effective disc cushioning—is one of the many reasons why Crane stop-checks have racked up this kind of service record in installation after installation. Ask your Crane Representative for full details, or write to address below.

IDEAS FOR YOU in this free book of "Valve Performance Facts." Your Crane Man has a copy for you.

CRANE VALVES & FITTINGS

PIPE • PLUMBING • KITCHENS • HEATING • AIR CONDITIONING

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accurate record of equipment operations is desirable, as at attended or unattended control stations.

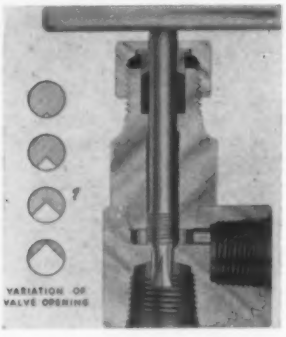
Basically this annunciator is a clock-printer and relay unit which monitors eight to 32 points per operational system. (Larger units are available.) It is designed to record the time equipment goes off-normal, and the time it returns to normal. If more than one piece of equipment in the system goes off-normal, information is recorded sequentially, provided occurrences are at least ¼ sec apart. Otherwise, information is retained and advanced to the printer in pre-determined order at the rate of four per second. The printer produces this in code form on paper tape — a record showing what trouble occurred and how long before corrected. Tape is advanced only after a printing. Panellit, Inc.

9—CHEMICAL FEEDER and water treatment regulator

Hydrotrol is announced for control of rust, scale, corrosion, slime and algae in recirculating cooling water systems for air conditioning, refrigeration and process cooling. Hydrotrol functions not only as a chemical feeder, but also as a treatment regulator designed to automatically and continuously synchronize rate of chemical feed and water bleed-off with load on system or amount of water evaporated, so as to maintain treatment without "drift" over relatively long periods of time. According to manufacturer, Hydrotrol saves 95 per cent of the labor required for service, analysis and adjustments, about 50 per cent on chemicals for air conditioning and cooling and on water unnecessarily wasted. Heller Laboratories, Inc.

10—BAR STOCK VALVE designed to prevent clogging

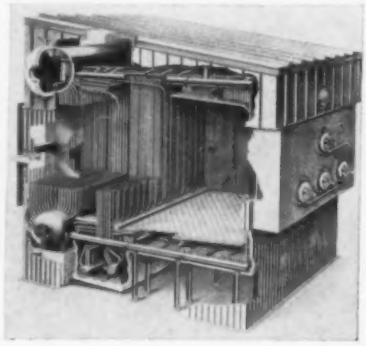
The Veegroo Tapered Orifice Valve offers a new concept of flow control and is designed to eliminate clogging problems. By moving a plug with a tapered slot into and out of a circular opening, the flow of fluid or gas is controlled by



the area of the slot at the head of the opening. This bar stock valve comes in standard sizes to 1 in., with pressure ratings 3000 and 10,000 psi. Materials available include carbon steel, three stainless steels, Monel, aluminum, and Alloy 20. Manufacturer says this valve will pass foreign particles up to 25 times larger than comparable needle valves. While its function is basically that of a needle valve, by concentrating all of the flow area in one triangular section instead of around an annular ring, it is claimed virtually clog-proof. General-American Valve Co.

11—STEAM GENERATOR offers "membrane wall" furnace design

This oil and/or gas fired, pressurized-furnace steam generator is designed for power, process or heating loads requiring steam capacities up to 400,000 lb per hr. The boiler offers "membrane wall" prefabricated furnace construction, which utilizes welded tubular furnace wall panels. According to company, high efficiency and elimination of induced draft fan are accomplished through pressurized-furnace design, with a subsequent savings in fuel, fan and power costs. Boiler operation is simplified because there is only one fan. Designated the PFI (Power For Industry) Boiler, the unit is available for steam pressures up to 1150 psi and for superheated steam temperatures to 900 F. It is designed for burning either oil or gas or a combination. Stand-by fuel is instantly available with the dual-fuel burner, since one fuel can be lighted from the other, manufacturer notes, and this avoids either a boiler outage or a drop in steam pressure when fuels are changed. The Babcock & Wilcox Co.



12—COLOR ALARM SYSTEM affords longer lamp life

Newest color sequence in the Electro-Pane line of annunciators is designed to eliminate need for a flasher. Although a flashing Electro-Pane is also available, company says the new color sequence provides for longer lamp life and still gives excellent discrimination between alarm condition and acknowledged condition. The backlighted nameplate is bright white during alarm condition. Pushbutton acknowledgement changes it to red. Upon clearance it changes to green or the nameplate can be automatically reset. Audible signals appear with white and green colors. Any sequence of colors can be substituted in the standard unit. Continuous filament monitoring is provided to eliminate necessity of pushbutton lamp test. Electro Devices Inc.

13—PACKAGED DRIVE mounts on single output shaft

In the Rectiflow Drive, an a-c motor, a d-c motor, and semiconductor rectifiers are integrated. These drives are announced as affording continuously variable speed control over ranges of 1½ to 1, 2 to 1, or 3 to 1; maximum speed is 1690 rpm. Power requirements are supplied from normal a-c distribution systems. Now available in ratings of 7½ to 125 hp or higher, they can be designed to serve either constant-torque or constant-horsepower applications.

Basically, the drive consists of a wound-rotor motor and a d-c motor built on a common output shaft. Grouped behind covers are step rings, commutator and brushes. Semiconductor rectifiers rectify slip power from wound rotor to supply direct current to d-c motor armature. A second set of rectifiers converts a-c line voltage to d-c to energize the shunt field of the d-c motor. Speed control is most simply obtained by varying a rheostat setting in this shunt field circuit, but the system permits inclusion of electronic and magnetic amplifier equipment for field control. In performance, these drives are said to demonstrate speed regulation of 7.5 per cent over full speed range. Full load efficiency over entire speed range is given as 85 per cent for 125-hp units and not less than 80 per cent for lower rated units. Rectiflow Drives are somewhat longer than comparable d-c motors. Westinghouse Electric Corp.

14—CRACK DETECTOR is low cost, portable unit

The Seal-Lock Magnetic Crack Detector is claimed to locate and outline any surface crack or fault on any ferrous casting. The unit weighs only 20 lb. It can be operated from either a 110 v a-c line, or 12- or 6-v battery, enabling crack inspection in areas where electrical lines are unavailable or not permitted. The detector is not affected by temperature or humidity, company states. Included in the complete unit are probe, a-c and d-c connectors, sprinkling bulbs, gray and yellow magnetic powders and instructions, all in steel case. United States Casting Repair Corp.

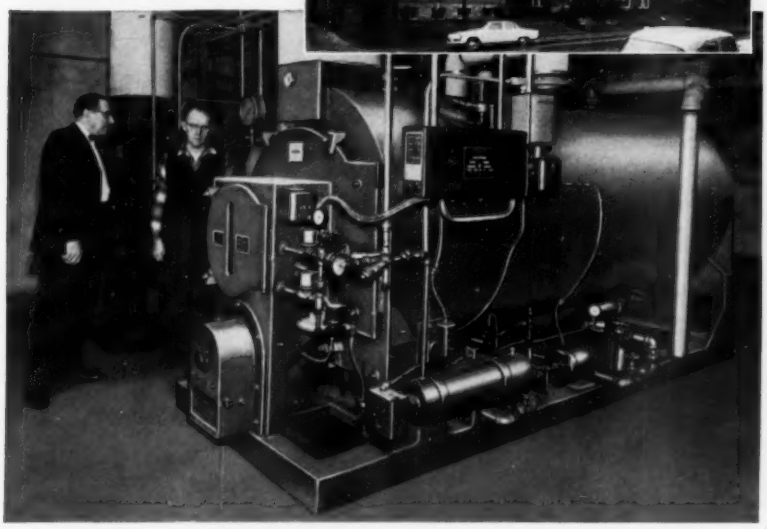
15—PNEUMATIC RELAY computes and compensates

This pneumatic relay is designed to solve equations continuously by combining two or more pneumatic signals in varying, predetermined proportions. It multiplies or divides one pneumatic signal representing a measured variable by some predetermined function of a second variable. Standard unit also adds and subtracts pneumatic signals and provides proportional control action. In process plants, it is suggested for rationing of two flows in multi-element control systems, and for pressure-temperature compensation of liquid or gas flow measurement. Relay uses standard SAMA ranges of 3–15 psig and 3–27 psig. Bailey Meter Co.

16—CONTROL VALVES for hydraulic and gas uses

In this line of check and flow control valves, a "straight-through" ball-valve design is incorporated to enable increased flow, greater dependability and a marked reduction in friction. Metal-to-

Two 75 H.P. Continental Automatic Boilers at Gordon Junior High School, Coatesville, Pa. Theodore Stetler (right) superintendent of maintenance shown with Merrill A. Squier, of Besco Sales, Continental Boiler representative.



HEATING COSTS CUT 21% with new Continental Boilers

In 1955, the Coatesville, Pa. school district purchased two new 75 H.P. Continental Automatic Boilers firing #5 oil to heat three adjoining school buildings from a central plant. The new boilers saved $2,614.51 in the first two years of operation. This is a 21% reduction in heating costs.

Merrill A. Squier, of Besco Sales, Continental Boiler representative in the Philadelphia area, says:

"You can count on Continental for highly efficient, low cost steam or hot water. Because of the simplified design, maintenance and downtime are cut to the bone. There are no refractory baffles to burn out, leak and cause short circuit of gases. Free rapid water circulation keeps heating surfaces clean. Steam and water spaces are easily checked through openings. Clean-out is easy."

Continental Boilers, firing oil or gas, are available in models from 20 to 600 H.P. with on/off, low-high-low, or modulating controls. For steam heating or process work at pressures from 15 to 250 lbs., or hot water heating at low or high temperatures. Literature on request.

BOILER ENGINEERING & SUPPLY COMPANY, INC.
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The Continental AUTOMATIC BOILER

A HALF CENTURY OF BOILER MANUFACTURING EXPERIENCE

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CALIFORNIA
El Cerrito—American Engineering & Mfg. Corp.
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COLORADO
Englewood—Champion Specialty Co.

DISTRICT OF COLUMBIA
Washington—Charles C. Plummer

FLORIDA
Jacksonville—H. L. McMurry & Co.
Miami—H. L. McMurry & Co.
Orlando—H. L. McMurry & Co.
Tampa—H. L. McMurry & Co.

GEORGIA
Atlanta—Mechanical Associates
Augusta—Tarte Boiler Repair Co.

ILLINOIS
Chicago—Automatic Steam Sales Co.

INDIANA
Indianapolis—Plibrico Sales & Service Co.
New Albany—Falls Cities Boiler & Machine

LOUISIANA
New Orleans—Cressy Sales Company

MARYLAND
Baltimore—Heating Services, Inc.

MASSACHUSETTS
Dorchester—Lewis National Corp.

MICHIGAN
Dearborn—Kramer & Associates, Inc.

MINNESOTA
Minneapolis—Oil Burner Service Co., Inc.
St. Paul—Lincoln Equipment Company

MISSISSIPPI
Jackson—Climate Engineers, Inc.

MISSOURI
St. Louis—Continental Boiler & Sheet Iron Works

NEBRASKA
Omaha—Midwest Utility Service Co., Inc.

NEW YORK
Buffalo—W. J. Clark Equipment Co.
Gloversville—Olin T. Caldwell & Co.
Hudson Falls—Boiler Equipment Co.
New York—Thermal International, Inc.
Rochester—Ernest J. Rookey
Syracuse—U & S Supply Corp.

NORTH CAROLINA
Greensboro—M. G. Newell Co., Inc.

OHIO
Cincinnati—Kenneth B. Little Co.
Cleveland—P. M. Equipment Co.
Toledo—Air Conditioning Distributors, Inc.

OKLAHOMA
Oklahoma City—Mecha-Line Co.

PENNSYLVANIA
Phoenixville—Besco Sales, Merrill A. Squier
Pittsburgh—John C. Gregg Company

RHODE ISLAND
Providence—Weatherall Engineers, Inc.

TENNESSEE
Knoxville—Boiler Supply Co.
Memphis—Middle States Associates, Inc.
Nashville—Boiler Supply Company

TEXAS
Dallas—Rodgers Engineering Co., Inc.
Fort Worth—J. P. Philibert

UTAH
Salt Lake City—Power Engineering Company

VIRGINIA
Suffolk—C. Fred Bailey

WISCONSIN
Milwaukee—Industrial Steam, Inc.

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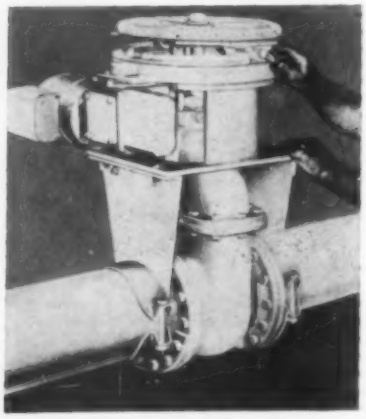
metal seats and "free-ball" mounting are used. The valves are female threaded to dryseal specifications in standard IPS ⅛ to ¾ in. and available from stock in brass, in steel, aluminum, stainless and special alloys to order. They may be utilized in pressure ranges to 2000 psi; and are said to be particularly adapted to high or low temperature ranges. Flow control valves are adjustable before, during and after installation. Sensitive adjustment is attributed to the design which controls the valve-ball itself, rather than the passage. True-Flo Valve Div., Mystic Machine Co., Inc.

17—FAN WHEEL inhibits fibrous material clinging

The Wool Wheel is announced as an industrial fan wheel designed for exhausting air containing clinging type fibrous material such as wool, cotton rayon and trim from corrugated box and paper machines. Constructed with a heavy back plate, fins and steel spider, the wool wheel features a sloping surface back of the fan blades to prevent fibrous material from clinging. In addition, fan utilizes a cone over the hub to further inhibit clinging action. Manufactured in wheel sizes ranging from 9½ to 60½ in., steel plate exhauster is claimed capable of moving 200 to 50,000 cfm of air at static pressures to 15 in. Fans are made in two classes for temperatures to 1000 F. Chicago Blower Corp.

18—VALVE CONVERSION UNIT for manual, power operation

You can convert installed valves from hand-operation to electric motor operation with Valvmatic, a push-button-operated valve actuating conversion unit, it is announced. According to company, unit can be installed without special engineering, disturbing piping or replacing existing valves. Company says Valvmatic can be used in nearly every application where valve handle doesn't rise, and where valve handle can rotate when valve is operating under power. In event of power failure, valve can be



restored to manual operation by removing two pins. Position and torque limits are provided in both directions of rotation to prevent valve injury. Valvmatic can be moved from one valve to another, and no special wiring is needed. It is not necessary to remove valve from line to install unit, company notes, nor is machining of special valve nuts involved. C. H. Wheeler Mfg. Co.

19—MOTION INDICATOR is low cost protective unit

Although primarily for process industries, the Roto-Guard is announced as applicable in other operations where positive indication of motion, or lack of motion, is required. This low cost protective device converts motion of various types into a signal. The signal impulse may be used to energize an alarm system or to operate control

switches automatically. Roto-Guard is connected to any slow turning shaft and as long as the driven shaft rotates normally the Roto-Guard, by means of a circulating pump and pressure-actuated switch, indicates normal operation. Should the shaft rotation slow below operating level, or stop, the resulting pressure drop would set off the alarm.

The Roto-Guard can be wired into an interlock system. In this way stoppage of one component in the chain of process equipment automatically will stop the other components to prevent damage, it is explained. The Roto-Guard is designed for operation at 10 to 150 rpm and is adjustable within that range. If the driven shaft operates at higher speeds a gear or pulley reduction may be incorporated. Form RG-16 gives data. The Bin-Dicator Co.

20—STEAM TRAP designed for tracing lines, other uses

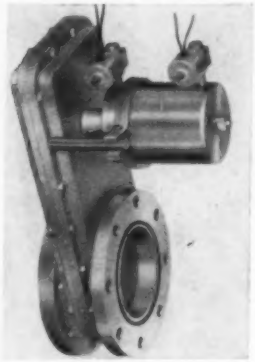
Especially designed for tracing lines and instrumentation service, as well as other applications, Type T steam trap has only three parts — cover, body and cage unit. The cage unit consists of a bimetallic element, a holder, a ball valve and a Stellited seat, ground lapped and tested for "air-under-water-bubble-free tightness." Unit is fitted in the body and held by two screws — in a matter of minutes a new cage unit can be installed, manufacturer states. Valve performs four functions — traps steam, vents air, discharges condensate, and acts as a check valve. It works on a wide pressure range — 0 to 50 psi, 0 to 200 psi. Velan Steam Specialties Inc.

21—VERTICAL MOTOR for indoor, outdoor service

The Climatized Vertical Hollow Shaft Motor is announced in ratings to 2000 hp for indoor and unprotected outdoor service in pumping applications. Its design is claimed to offer greater compactness and to incorporate insulating materials with optimum resistance to moisture and chemical contaminants and high mechanical strength. A maximum of two-high angular bearings are used in the motor to prevent excessive wear and reduced thrust capacity. Water-cooled Kingsbury type thrust bearings are utilized in extra-high thrust applications. Because of high motor efficiency a minimum of cooling air is required, company points out, and this permits low cooling air velocity and prevents dust and moisture from being drawn into the motor by the air stream. Further information is in Bulletin 2450. The Louis Allis Co.

22—CONTROL DEVICE converts linear to rotary motion

Although designed for a new line of high vacuum gate valves, this remote control device will be offered for a variety of control applications. With it linear motion is converted into a rotary motion with high torque, company announces. Linear movement of a guided plunger along a spirally fluted shaft in an pneumatically operated cylinder effects 180 deg of shaft rotation. Cylinders are simple and compact — a 3-in. diam one being 5½ in. long. Two standard models



accomplish a 180-deg turn, but design lends itself to construction which can effect a range up to several complete turns. They operate at nominal air pressures available in most plants, if necessary, down to 50 psi.

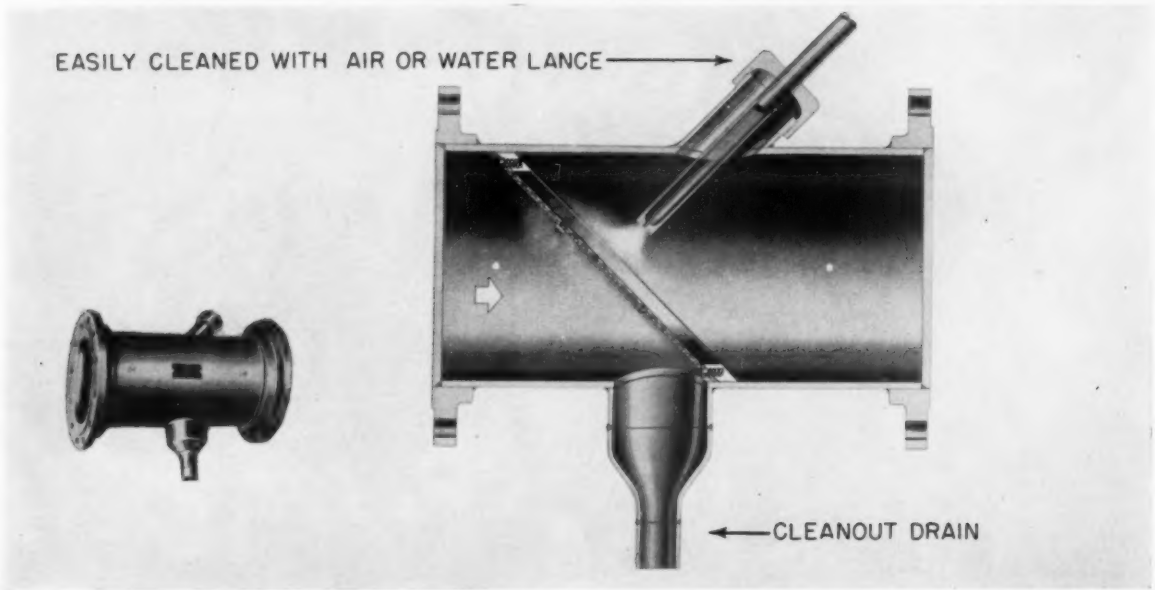
Operating speed is a feature of the control. Another advantage is that it permits manual operation in case of power failure where systems are based on electrically operated solenoid valves, also in case of air pressure failure. Also, says manufacturer, the device can be wired for automatic, instant closing or opening, according to needs, in case of power failure. Vacuum Research Co.

23—WATTMETER incorporates locking contact feature

Direct monitoring and control of electrical power by a single instrument is reported possible with this locking contact wattmeter. With the locking contact feature, high and/or low limits of wattage may be preset, with control action initiated when a limit is reached.

In this instrument, a core magnet movement has been added to the movement of a standard dynamometer type wattmeter. The former is on the same plane as the voltage coil of the wattmeter and moves with it as it turns within the field of the stationary current coil. When power being used reaches a preset limit, a contact on the indicating pointer touches a contact on a fixed pointer. A circuit is closed to an external slave relay that triggers control action. Current through contacts also flows through

NEW START-UP STRAINER CUTS CLEANING TIME FROM HOURS TO MINUTES !



With this new start-up strainer, you can provide positive protection for new boiler feed, condensate and any other close-fitted pumps and eliminate costly standby construction labor during start-up periods for new piping systems.

Flushes Clean in Minutes

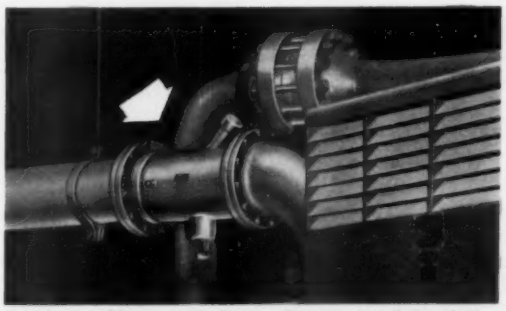
In actual field use, strainer cleaning time was cut from four hours (with basket, cone and disc types) to only ten minutes with the Leslie strainer. The strainer is easily cleaned by operating personnel with an air, steam or water lance as shown in the cutaway. Trapped debris flushes down the cleanout drain.

Easy to Install

Installation eliminates large complicated T's or angles. Screen is removed easily. You can leave the strainer body in the line after start-up or remove it for re-use and replace it with a spool piece. Available in sizes 6" to 16" steel construction with 150 to 300 lb. flanges.

More Information

Want more details? Just ask your Leslie Engineer. He's listed in your classified directory under "Valves" or "Regulators".



Here is one of 5 new Leslie Start-up Strainers installed on boiler feed and condensate pumps at New York State Electric and Gas Corporation's Milliken Station.

LESLIE

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STRAINERS

LESLIE CO., 301 GRANT AVENUE, LYNDHURST, NEW JERSEY

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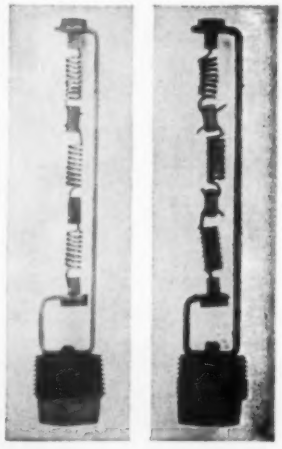
BIRD-ARCHER Amine Treatment
INSURES LONGER LIFE FOR PIPE

Return line corrosion is one of the most critical problems in maintaining economical, efficient power plant operation.

Bird-Archer Amine Treatment is an easy, effective and economical way to eliminate corrosion troubles. Amines raise the pH value of the return condensate to the point whereby the corrosion potential is negative. In addition, amines provide a surface protection for the metal itself which further inhibits corrosion. In scores of plants, Bird-Archer Amine Treatment is paying a profit on its cost through savings in piping replacement and maintenance work.

To demonstrate what corrosion can do in steam and condensate return lines, we show here "before" and "after" unretouched photographs of NDHA Corrosion Testers. This is a test* developed by the American Society for Testing Materials in cooperation with the National District Heating Association. Bird-Archer supplies and analyzes these testers. Photo at left shows a Tester before installation. Photo at right shows a Tester after it had been installed for 60 days in the return line. (*Standard Method of Corrosivity Test of Industrial Water, NDHA Method, ASTM Designation 935-49.)



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Offices also in Canada and Mexico

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coil of core magnet movement, which develops sufficient torque to lock the contacts together. The core magnet movement also furnishes damping torque for the voltage coil. In present models of the wattmeter, capacity of field coil ranges from 1 to 20 amp a-c. Instruments are calibrated so that, with a given amperage limit, watts may be read and controlled on the dial when nominal voltage is 110, 220 or 440 a-c. Assembly Products, Inc.

Reader Service Cards on pages 127–128 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

24—RUGGED PUMPS for the abusive applications

Pumps in the K series are designed for applications involving abrasion, corrosion and especially handling of hot liquids, because of the exposed shaft design. The pumps can be stationed above or below sump liquid level. These are single stage, end-suction pumps in sizes from 1 to 10 in. for heads — in some cases — up to 250 ft or more and for capacities in the range of 4000 gpm. These are three basic designs. Type KR, for limited heads, has end plate secured to housing by removable dogs. Type KC for corrosive or mildly abrasive applications, where frequent inspection is unnecessary, has a center split casing, the two halves being bolted together. Type KF, for high pressure abrasive or corrosive applications, has end plate secured to the housing by flanges and bolts. All types are available with simple slippage seal adjustment. Bulletin K gives data. Nagle Pumps, Inc.

25—GENERATING UNIT provides "on-the-spot" steam

This series of portable "plug-in" electric steam generating units is announced as providing a practical and economical means of obtaining high or low pressure steam, dry and odor-free, and ready for use in less than 5 min at any location. The units produce steam at low pressure (0–15 lb) and high pressure (100 lb) and range in size from ¼ to 5 hp. To oper-

Steel stack and breeching being gun-lined with refractory concrete (made with LUMNITE calcium-aluminate cement) at United Illuminating Company, New Haven, Conn. Gunite Contractor: Pressure Concrete Co., Newark, N. J.

ATLAS LUMNITE in stack linings . . . protects steel shell from corrosion and heat

- Refractory concrete linings (made with ATLAS* LUMNITE cement) resist the corrosive action of flue-gas condensate which forms on stack surfaces.
- Concrete retains high strength under continued exposure to heat and frequent heating-cooling cycles.
- Placement is fast, easy, economical — by guniting, pouring or plastering.
- Downtime is reduced because concrete reaches service strength in 24 hours.

For maximum convenience, use castables made with LUMNITE* cement. These are packaged mixtures, ready for use. Simply add water, mix and place. Made and distributed by leading manufacturers of refractories.

Write for "Lumnite Mortar Manual," describing gun-applied linings: Universal Atlas, 100 Park Avenue, New York 17, N. Y.

L-178

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"We've been having trouble with corrosion in this section."

Corrosion is embarrassing

It's *expensive*, too. Not only in terms of equipment chewed up, but also in un-timely time losses and wasted ingredients. You save embarrassment and expense *both* with Ace chemical resistant piping, valves, pumps, tanks, and special lined equipment. 108 years' experience at your service.

All-purpose rigid PVC. Sched. 40, 80 & 120, ½ to 4". Threaded or socket-weld fittings. Valves ½ to 2". NSF-approved. *Bul. CE-56.*

Improved design . . . now 12 gpm. All wetted parts acid-resistant, wear-resistant Ace hard rubber. Finest available. *Bul. CE-55.*

Flexible poly pipe, ideal for water lines, drains, underground pipe or conduit. Sizes ½ to 2", long coils, NSF-approved for drinking water. *Bul. CE-57.*

World's best chemical valves . . . at moderate prices. All-plastic, rubber-lined, or all-hard-rubber. ⅛" pet cocks to 24" gate valves.

ACE processing equipment of rubber and plastics

AMERICAN HARD RUBBER COMPANY
DIVISION OF AMERACE CORPORATION
Ace Road • Butler, New Jersey

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ate it, you just connect to electric service and city water lines. Units are claimed ideal for use where heavily saturated "wet" steam has caused difficulties, and for air conditioned facilities and crowded areas, since electric steam throws little or no heat. Electro-Steam Generator Corp.

26—DEHUMIDIFIER is large, high capacity unit

Model 1500 is suggested for moisture control in applications requiring a continuous supply of dehydrated air. It is designed to remove up to 40 lb of water per hour and to maintain humidity levels as low as 10 per cent. The machine uses two beds of permanent silica gel drying agent. While one bed removes moisture from the air, the other is regenerated by the most economical source of heat available, whether electrical, steam or gas. Alternate absorption and reactivation periods of the Model 1500 are spaced by adjustable timers to provide for economical operation under varying weather conditions. It requires only standard electrical connections and a minimum of duct work for installation, manufacturer announces. It has safety devices to prevent overheating and can be modified to include explosion-proof features. Each unit includes a humidistat for control over 20 to 90 per cent relative humidity. Dryomatic Corp.

27—OVERLOAD CLUTCHES for torque control, protection

The Safe-Torque line of mechanical overload clutches is announced for use as a subassembly or for attachment to a source of power. Two standard ratings of torque control clutches are: 0 to 84 in.-lb and 48 to 120 in.-lb. These clutches are reported to transmit more torque than other units of equal weight or size.

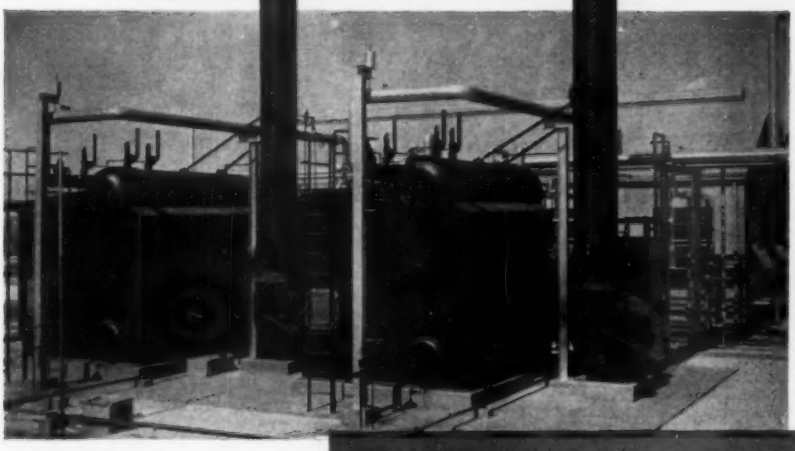
There are two general types — the one-shot, and the continuous overriding. Torque settings can be sealed against tampering, if desired. One-shot clutches may be re-engaged in one of several ways, depending on design: by reversing the rotation of the drive shaft; by axial movement (up or down); or by other means. Continuous overriding clutches are used on slow-running applications.

Overrunning roller drive of these clutches provides both precise and instantaneous release whenever preset torque is exceeded, it is explained; when clutch is operating within proper limits, rollers are wedged between inner cam drive and outer shell or body. All parts

Vogt

Package

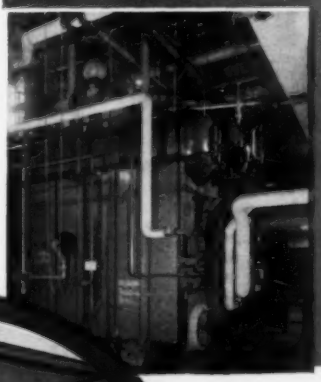
STEAM BOILERS *give* versatility with economy

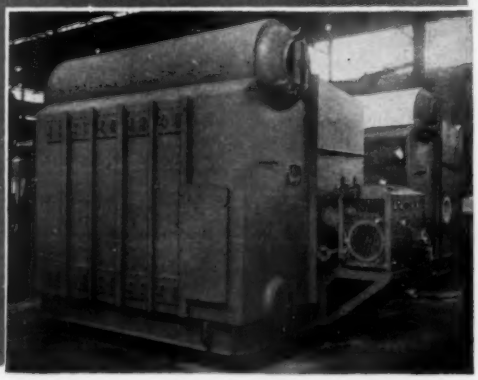


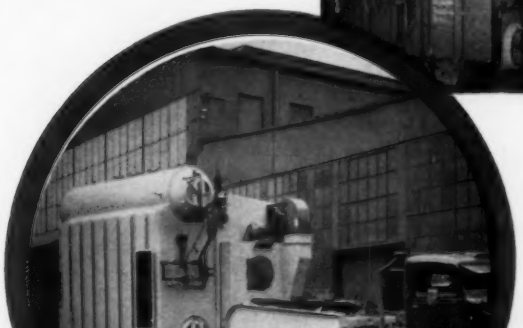
Above: Two units serve a gas pipeline company.

Left: Installation in fibre boxboard plant.

Right: Unit for a leading soap manufacturer.







Enroute to an office building.

FOR POWER, PROCESS OR HEATING

Available in capacities from 10,000 to 50,000 pounds steam per hour in three standard pressures of 175, 250 and 375 pounds per square inch gage, factory assembled.

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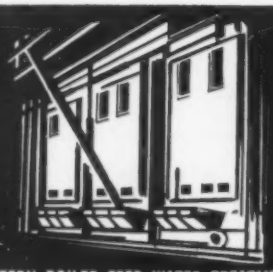
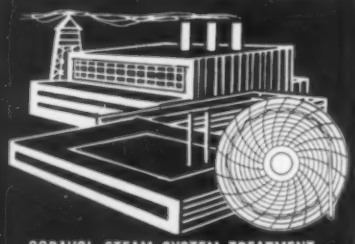
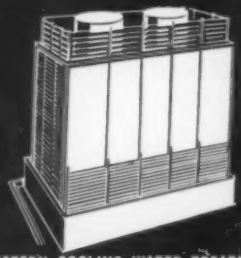


WESTERN BOILER FEED WATER TREATMENT



CORAVOL STEAM SYSTEM TREATMENT



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deform elastically when rollers climb into the wedging position. When manually preset torque is exceeded, rollers override the high points on the inner cam drive and roll into a free position. The driven member then becomes freewheeling and no further torque is transmitted. Scully-Jones and Co.

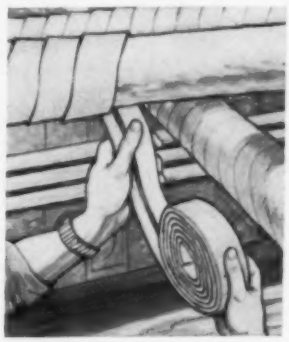
28—ROTARY COMPRESSORS offer savings in size, weight

These positive-displacement rotary compressors are announced as rivalling efficiency and stability of reciprocating machines while matching compactness and low maintenance of centrifugals. They are designed for continuous heavy-duty industrial service handling air, gas or vapor. With a standard capacity range of 800 to 13,000 cfm, it is expected to have application in the process industries for both pressure and vacuum systems; in heavy industry for industrial and instrument air, by-product gas boosters and exhausters, combustion air; in utilities for gas distribution and storage etc.

The new compressor design is a two, impeller, helical-lobe type, axial flow-rotary machine with four-lobe power impeller and a secondary impeller with six matching gaps synchronized by timing gears. Impellers rotate with a rolling motion and power is transmitted to the secondary impeller through the cushion of compressed gas. There is no metal-to-metal contact between impellers or with surrounding casing, it is explained, making it unnecessary to lubricate the impellers. Because of its high operating speed, the compressor can be driven by an induction or synchronous motor, diesel or natural gas engine, or steam or gas turbine. Though new in this country, this compressor is based on a Swedish design now in European service. Fairbanks, Morse & Co.

29—ASBESTOS WRAP protects electrical cables

Labor-saving Insulwrap is an asbestos tape $\frac{3}{16}$ in. thick, designed to replace three layers of $\frac{1}{16}$-in. listing tape as fire protection on electrical cables wherever they cross or run side-by-side. It is



claimed ideal for protecting cables in underground manholes, and to offer rugged insulation and reduced application costs when used on pipes carrying steam, chemicals, hot and cold water. It may be overwrapped with vapor sealing to prevent condensation. Insulwrap comes in 1- and 2-in. widths in 25-ft rolls; both have an extra half-inch of listing tape that overlaps each spiral. General Asbestos Gasket Mfg. Corp.

Snow doesn't melt over GILSULATE® covered underground steam lines

Steam line with 5" partial dirt backfill—steam turned into line. A light snow fell during the evening and still remained late the following day.

Indianapolis Power & Light Company chose GILSULATE for a recent installation on a busy downtown Indianapolis street. In addition to its outstanding insulating efficiency—snow didn't melt over a partially insulated line—and corrosion protection, GILSULATE's high loading capacity makes it the ideal choice for such an installation. The 6" line runs for 185 feet directly under the sidewalk, at an average trench depth of 4'6".

Nine tons of GILSULATE (type B for 300-385° F. temp. range) were used; only 100 man-hours were required to complete the job exclusive of excavation and backfill.

More and more, architects, engineers and contractors are discovering the *versatility* of GILSULATE.

For schools, railroads, hospitals, airports, utilities, housing projects—for big jobs or small—GILSULATE provides permanent corrosion protection for hot underground pipes at a cost far below that of any other pipe insulation system.

Investigate the value of this dependable, easily-installed, low-cost GILSULATE. Use the coupon below or see your local GILSULATE distributor.

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1. **EASY TO USE**—just pour and tamp...pipe heat does the rest.
2. **FORMS 3 ZONES** of protection against heat loss and all hazards commonly encountered by hot buried pipes.
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4. **ONLY NEEDS NORMAL PIPE SPACING:** for multiple pipe or cramped conditions.
5. **THREE TYPES AVAILABLE:**
   Type A for 220°-300°F. temp. range
   Type B for 300°-385°F. temp. range
   Type C for 385°-520°F. temp. range

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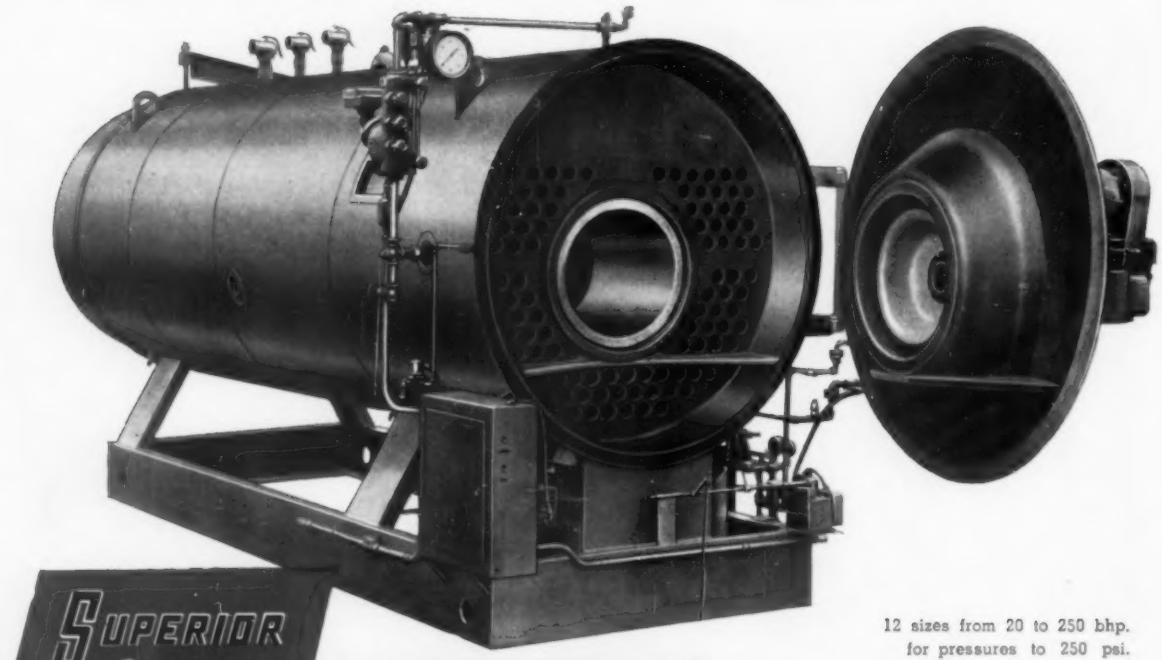

SUPERIOR "COMPACT"

12 sizes from 20 to 250 bhp. for pressures to 250 psi. or for hot water. Fully automatic operation firing oil or gas or both. Before you buy or specify any packaged boiler, get the details in Bulletin 1006-C

all the big boiler features you want combined with accessibility and easy maintenance

With a full 5 sq. ft. of heating surface per bhp., 4-pass, down-draft design, and built-in induced draft, the Superior COMPACT is a highly efficient and dependable package. Its efficiency, guaranteed by factory-fire-test of every unit, insures years of economical performance; for the Superior COMPACT is planned for the easy maintenance which sustains high efficiency.

Front doors are hinged, and rear doors hinged or davited to simplify inspection and cleaning. But note that no belts or mechanical components are located inside the front door where they would be subject to the heat of the fire. All units firing #4, #5 and #6 oil are equipped with dependable Superior Rotary Burners. High in the shell, and protected by the tubes of the fourth pass, the furnace is away from the "danger zone" eliminating the possibility of bagging or blistering.

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SUPERIOR PACKAGED BOILERS

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BOILERS, GENERATORS

201 Boiler Control System — Bulletin 1038, 12 pp, describes complete boiler control systems available for large utility power stations. Using a 900,000-lb-per-hr installation as an example, it gives a detailed description of each component, combustion, fuel cutback, pulverizer temperature, feedwater, and feed pump recirculation controls, as well as automatic-sequential soot blowing system. Copes-Vulcan Div., Blaw-Knox Co.

202 Boilers for Many Services — This general product data catalog in loose-leaf notebook form contains detailed literature on company's line of boilers for heating, power and process steam. It contains separate data sheets for each product, including high pressure boilers, low pressure boilers, boiler-burner units, water-tube boilers, water heating equipment and others. In addition to photos and diagrams illustrating design and operation features, it provides tabulated engineering data. Kewanee Boiler Div., American-Standard.

203 Fire Tube Boilers — This 12-pp catalog describes Superior Compact packaged boilers in capacities from 20 to 200 bhp. Interesting arrangement of text, illustration and color is used to explain many features of the units. Gives complete data and dimensions for boilers designed for firing oil or gas or both. Superior Combustion Industries, Inc.

204 Automatic Boilers — Bulletin BE-4 describes operation and advantages of Continental automatic boiler's spinning gas technique — a method of obtaining maximum heat transfer with a simplified design. Shows cutaway view of boiler construction; illustrates hinged doors and method of injecting air. Boiler Engineering & Supply Co., Inc.

205 Packaged Steam Generator — Advantages of company's baffleless, pressurized two-drum water tube packaged units are detailed in 12-pp Catalog SB-59. Features of the completely integrated generating plant, which requires no field piping, wiring, brickwork or special foundation, are shown on cutaway illustration. Erie City Iron Works.

206 Steam Generators — Twelve-pp Bulletin PSG-2 contains design and construction details on company's package unit steam generator — a vertical, bent tube, longitudinally fired water tube boiler. Capacities, dimensions and weights are tabulated and drawings, diagrams and photos showing fabricating methods included. Henry Vogt Machine Co.

207 Standard Generators — Bulletin BB-55-4 describes company's SC economy series of standard steam generators designed to reduce steam costs for indus-

AUGUST, 1958

NOTE: Card void after November 30, 1958

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trial plants. Pre-engineered, standardized steam generators offered in nine sizes, with capacities of from 50,000 to 150,000 lb per hour are described, and schematic and cutaway drawings of design features are included. Foster Wheeler Corp.

COAL AND ASH HANDLING

208 Improved Crushers — Bulletin 12-C, 16-pp, describes company's line of crushers for reducing coal, coke, glass cullet, gypsum, lime, metal turning, sugar, sulphur and similar lump materials. Covers Knittel ring type crushers, two-stage double-roll crushers, single-roll crushers, and double-roll crushers. Photos, dimensional drawings and full specifications are included. Stephens-Adamson Mfg. Co.

209 Coal Crusher — Company's WC and WS series rolling ring coal crushers are described in Bulletin 154. Emphasizes special construction elements that mean greater coal reduction at lower operating costs. Cross section illustration shows both feeding and crushing action incorporated and tables give capacities, speeds, and dimensions. American Pulveriser.

210 Why Stainless-Clad Steel — Advantages of stainless-clad steel for coal handling equipment are detailed in this 16-pp bulletin. Photo-stories of typical applications in hoppers, chutes, bunker noses, pipes and spreaders are included. Lukens Steel Co.

211 Jet Ignition Stoker — Information regarding company's jet ignition stoker is presented in Bulletin G-85. Rapid response to load change, ignition stability, efficient combustion, and a simple hydraulic drive are features described. Jet ignition stokers adapted to boilers in specific industries are shown and a typical fuel chart with comments and ASTM rank is also included. Babcock & Wilcox Co.

212 Water-Cooled Stoker — Design and operating advantages of the Vibragrate Stoker are outlined in this illustrated bulletin. A large cutaway view details component parts of the stoker and explains operating features. Other drawings show installations. American Engineering Co.

TUBING AND ACCESSORIES

213 Heat Exchanger Tubing — Cited in this 30-pp catalog are typical cases where cupro-nickel or Monel tubing installed in heat exchangers resulted in substantial savings and better efficiency through longer tube life. Describes applications of this tubing in various instances where unusual water conditions, as to pollution, excessive turbulence, temperature and the like, required such tubing. The International Nickel Co., Inc.

214 Tube Expanders, Cutters — Catalog 81, 32 pp, contains specifications of company's line of tube cutters and expanders for fire tube and water tube boilers, condensers-coolers, heat transfer units, refinery still tubes, others. Also gives necessary information on operating accessories. Many excellent demonstrations of product application are included among the 300 illustrations provided, as well as tables of sizes. The Gustav Wiedeke Co.

215 Tubes and Plates — Publication B-2, 46 pp, covers the subject of tubes and

A plant built on the philosophy of "don't accept anything at face value"...

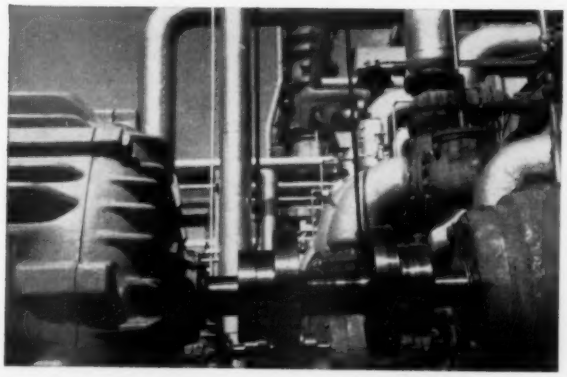
Tidewater's "Refinery of the Future" Uses 471 Fast's Couplings to Reduce Maintenance

IN PLANNING Tidewater's Delaware Refinery, all equipment purchases were examined from every angle . . . capital investment, manpower, maintenance and reliability. Fast's Self-Aligning Couplings were used throughout because they met Tidewater's exacting demands.

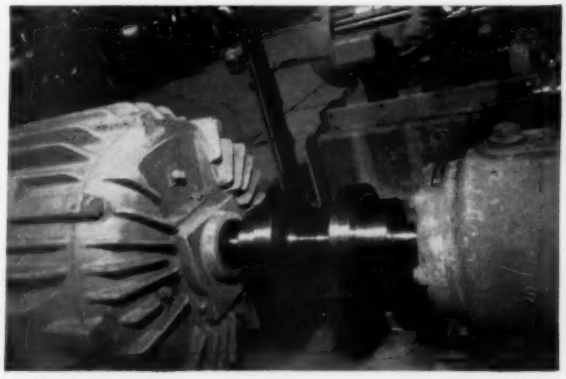
Tidewater's equipment design policies were established by survey teams that visited refineries all over the country. They carefully appraised each plant and asked operators what improvements they would make and what features they would retain if they were to redesign their drives.

In 471 applications at this refinery, Fast's Couplings guarantee mechanical flexibility that eliminates costly shutdowns and expensive shaft replacements. Fast's have the reputation of frequently outlasting the equipment they connect. This means savings in maintenance and down-time . . . in addition to protecting costly equipment against errors of alignment.

Nearly 40 years of coupling experience qualifies Koppers to solve *your* coupling problem. Write today for full details to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 3708 Scott Street, Baltimore 3, Md.



Fast's Couplings give dependable, trouble-free service throughout Tidewater's entire production facilities.



This Fast's Coupling drives a pump delivering heavy naptha to the Solutizing plant.

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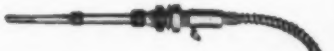
Which of these characteristics are essentials on your Remote Control Jobs?

• Accuracy . . . High Load Capacity . . . Adaptability . . . Freedom from Trouble . . . Long Life . . . Flexibility . . . these are some of the qualities of ACCO TRU-LAY PUSH-PULL *flexible* CONTROLS that have made it possible to improve the operation of literally hundreds of mechanical products (list on request). Full description of this versatile REMOTE CONTROL is given in our DATA FILE available for your further study.

ACCURACY is inherent in the basic design, and in the standards of quality and precise dimension that control the manufacture of TRU-LAY PUSH-PULL CONTROLS. These are precision products, not gadgets.

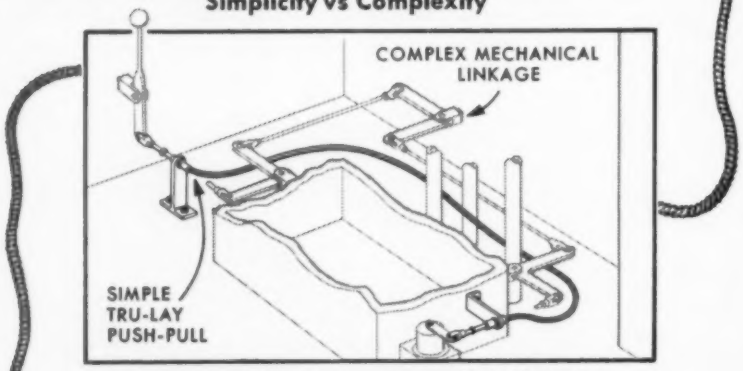
VERSATILITY of this fine remote control can best be illustrated by citing some of the jobs it handles well . . . HOT jobs on jets and industrial furnaces . . . COLD jobs down to —70°F . . . WET jobs (the conduit can be completely immersed) . . . DIRTY jobs . . . ABRASIVE jobs . . . CORROSIVE jobs . . . HEAVY, TOUGH jobs up to 1,000 lbs. input . . . LIGHT DUTY jobs . . . REMOTE jobs 150 feet or more from the control point. These units are frequently and successfully used in conjunction with electric, hydraulic and air controls . . . are thoroughly effective under almost any operating condition.



"Solid as a rod but flexible as a wire rope" aptly describes TRU-LAY PUSH-PULL CONTROLS. This flexibility provides positive, remote action whether anchorages are fixed or movable . . . it damps out noise and vibration . . . protects delicate instruments . . . it permits ease of handling and shipping even when assemblies are 100 or 150 feet long . . . it avoids the risk of damage always present with solid tubular controls that must be preformed to position . . . and flexibility greatly simplifies installation of controls by reducing the number of working parts and by making it possible to snake around obstructions.

Advantages of Tru-Lay Push-Pull flexibility and simplicity are pictured below

Simplicity vs Complexity



Compare the TRU-LAY PUSH-PULL cable in illustration with the mechanical linkage. PUSH-PULLS are simple, have but one moving part, are noiseless and give lifetime service accuracy. Linkages are complex, made of many parts; they wear at many points. Their use brings increased back-lash, lost accuracy and vibration rattles.

• Whether your interest is in a single application of this versatile PUSH-PULL CONTROL, or in its inclusion as a component of the product you manufacture, the six booklets and bulletins in this DATA FILE will answer your further questions, and will also provide you with the means of defining to us the applications you may be interested in.

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AMERICAN CHAIN & CABLE

Push-Pull DATA FILE

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plates for condensers and heat exchangers. Fields of application and particular problems encountered in each are described. Information on condenser tube alloys, plates for tube sheets and baffles, manufacturing methods, installation, operational factors affecting tube life, corrosion factors in condenser tube service is presented. The American Brass Co.

216 Electric Tube Cleaners — Bulletin E107 describes advantages and applications of company's electric tube cleaners for boilers, condensers, evaporators, and heat-exchangers. Tables are included giving complete specification details. Elliott Co.-Roto Plant, Div. of Carrier Corp.

FUEL BURNING EQUIPMENT

217 Steam Atomizing Oil Burners — Sixteen-pp illustrated Bulletin 21 describes steam atomizing oil burners and auxiliary equipment for use with heavy oil or tar in boilers, stills, dryers and other furnaces where steam or compressed air is available for atomizing the oil. Includes information on furnace design and construction. National Airoil Burner Co., Inc.

218 Self-Aligning Coupling — Form 273-M50 describes principles and features of company's all-steel, self-aligning coupling for shaft sizes up to 3⅛ in. Variations and modifications are illustrated and a table of coupling ratings and dimensions is included. Metal Products Div., Koppers Co., Inc.

REFRACTORIES, INSULATIONS

219 Refractory Castable — Bulletin R-40 describes the use of Kaocrete, company's refractory castable, in boiler ashpits. A discussion of the various methods of ash removal, along with the maintenance problems peculiar to each, is presented. Four installations detailed. Refractories Div., The Babcock & Wilcox Co.

220 Refractory Mortar — This is a 24-pp manual covering the use of Lumnite calcium-aluminate cement as a mortar mix for gun-applied linings in power plant, refinery and metalworking equipment. Includes data on mortar preparation, placing procedures, curing; also general instructions, and information on use of Lumnite cement as a masonry mortar for laying brick. Universal Atlas Cement Co.

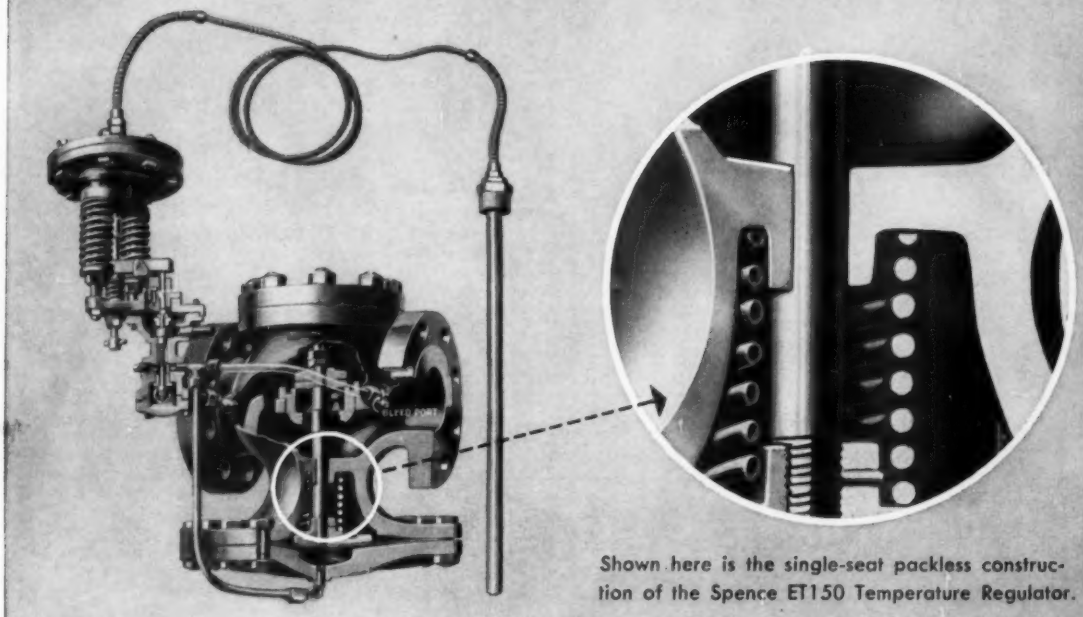
221 Underground Pipe Insulation — This illustrated bulletin discusses the problems of underground pipe insulation and explains how company's insulation for hot underground pipes overcomes them. On-the-job photos illustrate ease of application; brief technical data are also included. American Gilsonite Co.

222 Pipe Insulation — This 40-pp catalog was designed as a reference guide to company's pipe insulation, presenting a new way to specify proper thickness for pipe insulation, based in the "J" factor. This special index eliminates complicated computation formerly required to determine economical thicknesses. The book also features detailed drawings that show how single-layer insulation is applied to various vertical and horizontal expansion joints as well as to pipe bends, flanges, valves. Union Asbestos & Rubber Co.

223 Insulating Block — An insulation block fabricated from high temperature resisting minerals and effective up to 1700 F is described in this 8-pp bulletin. Provides thermal conductivity graph, size

VALVE TIPS:

Advantages of Packless Construction in Temperature Regulating Valves



Shown here is the single-seat packless construction of the Spence ET150 Temperature Regulator.

One of the biggest headaches in regulating valve maintenance is repacking stuffing boxes.

How often a valve needs repacking, how much time it takes, and the cost of the system downtime all vary with the construction of the regulator and the service it's used for. No matter how you calculate all these variables it's still a headache—and an expensive one.

In the temperature regulator shown above (Spence Type ET150) stuffing boxes are eliminated. This is done by what is known as "balanced" diaphragm construction. You can see in the cutaway drawing that pressure is applied to both sides of the large metal diaphragm. The upper side is exposed to delivery steam pressure and the lower side is exposed to loading pressure applied by the pilot. When the pilot closes, both delivery pressure and loading pressure are equalized through the bleedport and connecting tubing.

This construction not only does away with repacking problems, but it makes possible additional savings as well. For example, you will note in the sectional blow-up that this design eliminates a closely fitted stem and guide. Dirt or other foreign matter doesn't have much of a chance to lodge between these parts and cause sticking.

Another cause of binding or sticking, uneven expansion of closely fitted parts, is also eliminated with this design. In addition, valve stem wear is reduced for the same reason.

Lower maintenance is not the only advantage of this packless construction. Accuracy of regulation is also improved because friction due to a stuffing box, dirt, or uneven expansion is not a problem. The large, *balanced* metal diaphragm is more sensitive to slight changes in pressure.

Guaranteed Not To Wiredraw

If seats and discs are cut by steam (wiredrawn) the loss of steam through these grooves can be another expensive item — directly charged against the regulating valve. Fortunately, you can eliminate these costly leaks by specifying a temperature regulator that is *guaranteed not to wiredraw.*

Spence makes such a guarantee because their seats and discs are made of SECO Metal. Over 20 years experience with this special alloy has failed to produce a single case where a SECO Metal seat or disc had been cut by steam. All that's required is an approved strainer located ahead of the regulating valve. Expensive steam leaks just can't happen with this combination of SECO Metal and single-seat design.

If you would like to have more information on Spence Temperature Regulators, drop us a line and ask for Bulletin T150. It gives more detailed information on these and other Spence design features. Piping layouts and helpful information on the installation of temperature regulators are also included. Write for your copy today.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

SE 140

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You can't beat all-plastic Dekoron Poly-Cor for chemical resistance or for ease of installation. And now, the *new* Dekoron Instrument Tubing Harness adds yet another revolutionary feature—*fire resistance.*

For example, in the direct flame of a cutting torch, it lasted longer than any other multiple-tube harness. Use it in areas where flash fires are anticipated. And *new* Dekoron Instrument Tubing Harness is rugged, too. You can bury it and forget it.

You get all the advantages—chemical, impact and fire resistance—wrapped up in a single bundle with *new* Dekoron Instrument Tubing Harness. Remember, you can burn it . . . you can bang it . . . you can bury it. And you can *buy it now.*

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DEKORON PRODUCTS DIVISION
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and thickness data, describes insulating-finishing cement. Baldwin-Hill Co.

VALVES, TRAPS AND PIPING

224 Boiler Blow Off Valves — Bulletin E-125, 24 pp, describes and illustrates the design and construction of company's quick-operating valves, angle valves, Y valves and duplex units specifically designed for boiler blow-off service. Includes dimensions. Everlasting Valve Co.

225 Composite Valves — This 24-pp catalog, Form 186, features company's line of bronze, iron, steel and corrosion resistant valves. In addition to descriptions of component features, it contains photos, cutaway views and complete specifications. The Wm. Powell Co.

226 Regulating Valves — Bulletin 5305 describes double seated diaphragm regulating valves for use with control instruments, outlining special features of the valves, particularly the "flow line" contoured-body engineered for high capacity at low pressure drop. Leslie Co.

227 For High Pressures, Temperatures — Bulletin B-453, 12 pp, describes company's high temperature and high pressure valves for service in steam power plants and related installations. Cutaway views illustrating design and construction features are included, as well as temperature-pressure ratings table, selection chart, dimensions, weights. Yarnall-Waring Co.

228 Butterfly Valve Manual — Forty-pp Catalog B-2 is designed to help power engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and describes rubber seat butterfly valves from 4 in. diam up, for handling liquids and gases. The Henry Pratt Co.

229 Check Valves — Twenty-pp Catalog 30A presents company's line of tilting-disc check valves made in iron, bronze and steel for working pressures to 2500 psi. Explains operating principles of tilting disc construction, discusses closing without slam, reduced loss of head, other advantages. Includes construction details, sizes. The Chapman Valve Mfg. Co.

230 Choosing the Right Valve — Presenting valve selection as a matter of matching the valve's service characteristics with service requirements of the job, this practical 20-pp booklet explains and illustrates basic design features of gate, globe and check valves. It tells, in non-technical language, how each of these valve types works, and where it is suited for use. Disc, stem connection, bonnet and bonnet-joint characteristics covered. Crane Co.

231 Industrial Valves — Bulletin 507V illustrates and describes company's line of industrial valves for control of air, gas, liquids and solids. Features photos and descriptive detail on a variety of valves, including butterfly valves, wafer butterfly valves, treaded butterfly valves, slide valves, check valves, proportioning valves and others. W. S. Rockwell Co.

232 Industrial Valves — Condensed Catalog 105, 28 pp, contains data on valves for a wide variety of applications. Includes dimensions and illustrations, describing non-return (stop-check) valves, globe and angle stop valves, pressure seal design, angle univalves and small size globe valves

designed for chain or extension operation in vertical lines. Edward Valves, Inc.

233 Swivel Joints — Advantages of company's self-aligning swivel joints for steam, hydraulic and other applications are detailed in 12-pp Catalog 265-B. In addition to dimensional data, working pressure ratings, specifications and installation details, it includes photos, cutaway views, diagrams. Barco Mfg. Co.

234 Water Hammer Control — Cause, effect and control of water hammer in piping systems is the subject of 8-pp Bulletin WH 851. Photos, drawings and curves supplement text, and tests data is presented to show efficiency of company's silent check valves in water hammer control. The Williams Gauge Co., Inc.

235 Steam Trap Book — Catalog J, 44 pp, serves as a manual of trapping practice. Includes a catalog section giving physical data and prices on cast semi-steel and forged steel inverted bucket steam traps, compound steam traps and ball float air and air relief traps; a handbook section explaining how to calculate condensate loads and select traps for all classes of equipment; a maintenance section explaining trap installation, as well as repair. Armstrong Machine Works.

236 Materials for Main Steam Piping — Entitled "The Plastic Ductility of Austentic Piping Containing Welded Joints At 1200 F," this 16-pp bulletin deals with an investigation into the problem of selection of materials for main steam piping. Gives stress rupture characteristics of type 316 and 347 stainless steel piping adjacent to welded joints. Pittsburgh Piping and Equipment Co.

237 Flexible Hose, Bellows — Sixteen-pp Catalog 156 describes applications and use of flexible metal hose and bellows. Engineering specifications and sizes, pressure ratings, materials and fitting attachments are included. Detailed drawings and pictures facilitate specification of individual applications. Flexonics Corp.

238 Industrial Expansion Joints — Advantages of company's line of industrial expansion joints designed for rugged temperature and pressure extremes are detailed in this illustrated brochure. Typical applications are pictured. Solar Aircraft Co.

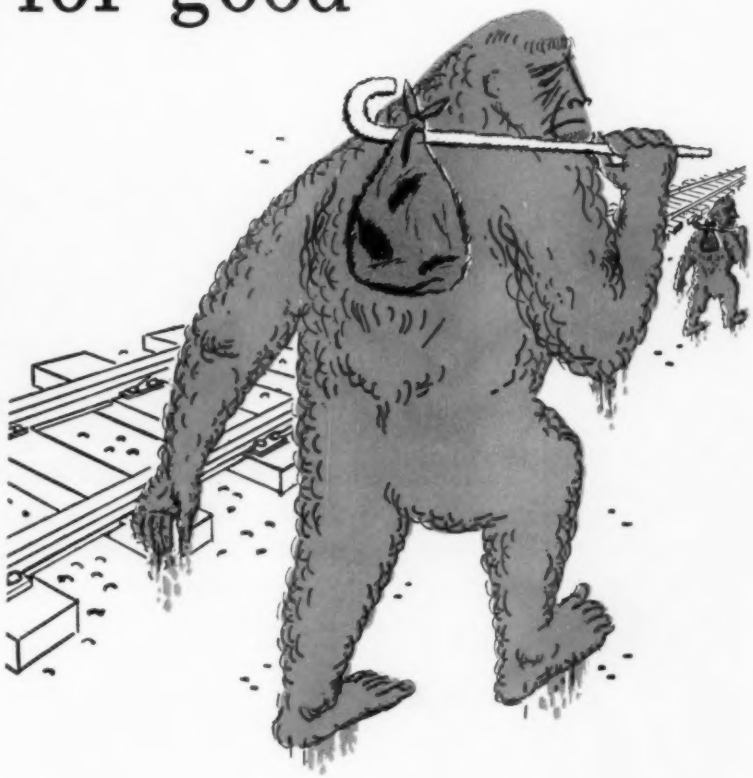
LUBRICATION

239 Versatile Industrial Oil — Described in 20-pp Form AD 4078 is an all-purpose oil offering protection for a wide range of industrial equipment, and available in 15 viscosity grades. Discusses six major characteristics of the oil; explains and pictures its use in hydraulic systems, speed reducers, air compressors, electric motors, hydraulic turbines, bearing systems, etc. A chart shows grades available, uses, properties. Standard Oil Co. (Ind.)

Postage-free cards for ordering catalogs are on page 128. You may also use the cards to order literature mentioned in the ads.

240 Lubricants — Specification, Classification — Vital information on selection of lubricants is presented in 10-pp Vol. 41, No. 4 of "Lubrication." Covers such items as performance specifications,

Algae's gone for good



Algae formations in condensers, spray towers, cooling ponds, reservoirs, air conditioning equipment and other water systems can cause costly problems if allowed to develop.

These problems can be solved, simply and economically, with HTH Granular, containing 70% available chlorine. Dry HTH Granular is free-flowing, dissolves quickly, and gives fast, effective algae kills. It can be applied easily and safely—no expensive equipment or specially trained personnel are needed.

For complete information on the use of HTH for algae control, write to:

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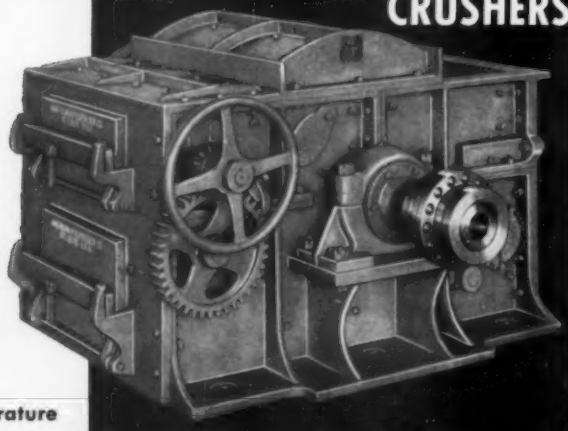
AMERICAN AC ROLLING RING COAL CRUSHERS



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for uniform coal reduction rely on coal crushers backed by American's 50 years of experience

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ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

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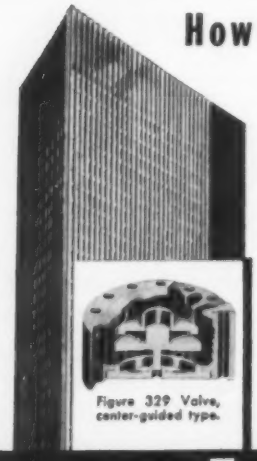
How to silence 38 stories of piping

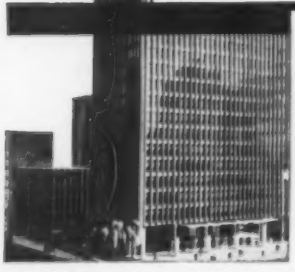


In the new Seagram Building in New York, Williams-Hager Silent Check Valves control water hammer. They silence and protect piping by operating instantly when flow reversal starts or when flow is zero. Just one of hundreds of outstanding buildings protected by Williams-Hager Valves.

Figure 329 Valve, center-guided type.

Write for Bulletins

—No. 654 on Valves, No. 851 on Cause, Effect and Control of Water Hammer



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initual suitability of lubricants, quality of lubricant, effect of lubricant on production, effect on maintenance, effect on power, effect on cost, and features a look to the future. The Texas Co.

WATER CONDITIONING

242 Water Treatment — Bulletin 5000, 24 pp, explains the reason for boiler water treatment and tells services offered by company in providing formulations for individual plant requirements. Covers pretreatment, internal treatment, treatment application, blow-down adjustment, test control. Dearborn Chemical Co.

243 For Boiler Protection — Scav-Ox, a 35 per cent hydrazine solution for removing dissolved oxygen from boiler feedwater, is described in this 16-pp illustrated booklet. It covers in detail the use of the solution for protecting low, medium and high pressure boilers, discussing determination of dosage, recommended methods of application, testing methods for hydrazine and properties and handling of the material. Olin Mathieson Chemical Corp.

244 Evaluating Steam Purity — Technical Paper 135, 88 pp, entitled "Conductivity vs Sodium by Flame Spectrophotometry. In Steam-Purity Studies," present results of laboratory and plant work to indicate that sodium is extremely valuable in evaluating steam purity. Performance curves are included in the paper. Betz Laboratories, Inc.

245 Feedwater Treatment — Process Bulletin B1, "Treatment of Boiler Feedwater by Direct, or Internal Method," discusses advantages of direct treatment, as a complete treating program or as a supplement to external systems. Explains why direct treatment is convenient, economical. National Aluminate Corp.

246 Feedwater Heaters — Open-Coil, tray-type feedwater heaters and purifiers of both deaerating and nondeaerating type are presented in 12-pp Bulletin 117-A. Construction and operational features of the heaters are explained and illustrated, and more than a dozen available models are pictured along with application suggestions. They cover capacities from 3000 to 300,000 lb per hour. Stickle Steam Specialties Co.

247 Boiler Water Treatment — Chemical reduction of oxygen in boiler feedwater with hydrazine is the subject of 10-pp Bulletin BW-7. Economy and operation, handling of the Deoxy-Sol, methods of analysis and other details are covered. A bibliography lists supplementary reading. Fairmont Chemical Co., Inc.

248 Mixed-Bed De-Ionizers — Practical equipment for mixed-bed de-ionization of flow rates of 5 gph to 5000 gpm is described in this 8-pp bulletin. Advantages of construction and design are detailed, as well as mechanical features, installation operation. Illinois Water Treatment Co.

249 Valveless Filter — Operation of company's automatic valveless filter is described in this 8-pp illustrated bulletin. Applications and typical operating conditions are detailed and diagrams and photos are included. The Permutit Co.

250 Anti-Foam Agent — A cure for carryover of boiler water due to foaming is described in this illustrated brochure on Concentrol — a surface active agent of the polyalkylene glycol group. Before and

after photos illustrate performance characteristics in test case. The Bird-Archer Co.

251 pH and Chlorine Control — The 13th (1957) edition of company's handbook, "Modern pH and Chlorine Control," 100-pp, incorporating theory and practice of colorimetric analysis, serves as a reference for quantitative determination of pH, chlorine, phosphate, nitrate, sulfate, hardness and other tests. Slide comparators and complete test kits are illustrated. In addition to standard pH determinations, methods are outlined for quantitative analyses of phosphate, calcium magnesium, silica nitrate hardness. Available to qualified power engineers, please state your job title. W. A. Taylor Co.

252 Demineralization Data — Bulletin WC-111A, 32 pp, is company's revised booklet on demineralization (ion exchange). In addition to basic sections on application of demineralizers, principles of operation and chemistry of ion exchange resins, this bulletin includes detailed information and charts on design and materials of construction. Includes comparison charts on multi-bed, mixed-bed and scavenger or polishing demineralizers. Detailed layouts of each type of system are provided. Graver Water Conditioning Co.

253 Handbook on Demineralizing — Comprehensive 40-pp Bulletin 5800 compares various methods of water treatment, indicating the comparison between demineralizers and evaporators. It discusses the characteristics of the various types of available cation and anion exchange materials and offers data on operating costs of demineralizing. It tells when to use two-bed, three-bed, four-bed, mixed or mono-bed types. Cochrane Corp.

PUMPS, COMPRESSORS

254 Controlled Volume Pumps — Bulletin 953, 24 pp, describes and illustrates use of controlled volume pumps in industrial water treating systems. Construction and operation features are described, capacity-pressure ranges and speed and stroke length adjustments are charted. Typical chemical feed and water testing systems are presented through text and diagrams; and an analysis of boiler water treating systems, cooling water treating problems, others, also included. Milton Roy Co.

255 Solids Handling Pumps — Bulletin 121-A, 8 pp, describes a complete line of non-clog pumps for handling solids in suspension. Included are vertical, horizontal and close-coupled types used to handle liquid components of industrial processes, industrial waste, and for such pumping applications as water supply, drainage and sewage handling. Specifications are included. Aurora Pump Div., The New York Air Brake Co.

MECHANICAL POWER TRANSMISSION

256 Controlled Speed Systems — Eight-pp Booklet F-1952 describes typical installations for controlled automatic variable speed systems, including control of liquid level, pressure, rewind tension, speed sensitivity, load, position or link synchronization, temperature, multiple drive conveyors, wide range speed, others. Provides information on determining preliminary planning and obtaining maximum operating efficiency. U. S. Electrical Motors Inc.

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257 V-Belt Drives — Bulletin A-661, 110-pp, includes valuable engineering information, selection tables, drawings, photographs and prices for Taper-Lock Sheaves Sealed-Life V-Belts, Flexlink Belt and variable speed drives. Tables provided to facilitate selection of pre-engineered drives. Dodge Mfg. Corp.

INSTRUMENTS, CONTROLS

258 Meters and Controls — Over 100 measuring, transmitting, receiving, recording and indicating instruments and control components, including those introduced within the last year, are described in the 8-pp 1957 edition of company's Bulletin G15-1. Applications, ranges, and detailed literature references are given for each product. Bailey Meter Co.

259 For Feedwater Analysis — Bulletin 148BP contains a technical discussion of manufacturer's analyzers for determination of dissolved oxygen and hydrogen in feedwater. Discusses both O and H units as to function, ranges, accuracy. Cambridge Instrument Co., Inc.

260 Easy Reading Gage — An all-hydrostatic remote reading gage for boiler water and other liquid levels is described in Catalog 500, Section CO. Pictures improved visibility, other advantages offered by this gage, and explains operation. The Reliance Gauge Column Co.

261 Guide to Gages — Catalog 300-B, 112 pp, features Ashcroft Duragauges, Maxisafe, pneumatic receiver, recording, quality, drawn case, chemical and special application gages. Also presented are gage testers, pneumatic transmitters, gages for nuclear energy. Engineering data and charts are provided. Instruments shown cover dial sizes from 2 through 24 in., pressures from 30 in. vacuum or a few ounces up to 100,000 psi. Manning, Maxwell & Moore, Inc.

262 Temperature Regulators — Ten-page Bulletin 620-2 describes features and advantages of company's line of temperature regulators consisting of a thermostat with capillary tubing and a valve. Includes information on typical applications, as well as dimensional data, diagrams, discharge pressure curves, and a valve selection chart. Sarco Co., Inc.

263 Ring Balance Meters — Specification Sheet PM-10002 features a line of ring balance meters designed to convert fluid differential pressure measurements into flow records and indications. Includes description of operation, specifications, internal views showing components, and tabulated data. Hagan Chemicals & Controls, Inc.

264 Instruments and Controls — Catalog 57-6 describes instruments and controls, including flow meters, liquid level or pressure gage, CO_2 meters, boiler meters, pneumatic transmitters, strip chart recorder, pressure, vacuum and differential recorders, temperature recorder, multipoint gages and others. Includes descriptive data and illustrations. Republic Flow Meters Co.

265 Ideas on Push-Pull Controls — Included in this "Idea File" are answers to a power engineer's questions on the use of push-pull controls. A general information booklet discusses remote control applications, explains construction and operation of company's Tru-Lay controls. Separate bulletins are devoted to standard

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assemblies, bracket-type head controls, micro controls and hand-operated controls. Automotive and Aircraft Div., American Chain & Cable Co., Inc.

266 Temperature Regulators— Six-pp Bulletin 1012 describes company's line of steam regulating valves with pilots for both fast and slow heating exchangers. Selection tables and line drawings of typical applications are also included. Spence Engineering Co., Inc.

HEATING

267 Overhead Heating Units — Bulletin P 1-57, 16-pp, contains photographic reproductions of overhead gas-fired heaters, as installed in a variety of commercial and industrial plants. How this type of heating solved specific heating problems is told. Prat-Daniel Corp.

268 Unit Heaters — Bulletin FAS-1, 24 pp describes horizontal and vertical discharge unit heaters for replacing process exhausted air with warmed fresh air and for comfort ventilation. Dimensions, capacities, and suggested methods of installation are given, and photos and drawings are included. L. J. Wing Mfg. Co.

ELECTRICAL EQUIPMENT

269 Testing Instruments — Bulletin 19-58, 16 pp, features company's electrical testing instruments, including ohmmeters, ground testers, dielectric test sets, motor rotation tester, cable fault locating equipment, transformer turn ratio test sets, corona test equipment, frequency meters, tachometers, others. Includes photos and descriptions of each type, covering chief features. James G. Biddle Co.

270 Handbook on Fuses — This 12-pp booklet contains practical information on how to get safe, dependable, trouble-free electrical protection. Shows what to do when fuses blow, how to determine cause of blows, what kinds of fuse to use for various circuits. Contains short history of fuses and notes on construction of fuses. Bussman Mfg. Div., McGraw-Edison Co.

271 Electrical Enclosures — Bulletin EE, 14 pp, describes company's line of sheet metal electrical enclosures and other related items for a variety of applications. Covers control desks, electrical cabinets and enclosures, power distribution and control panels, boiler, turbine generator control panels, switchgear housings, and others. The Kirk & Blum Mfg. Co.

272 Integral Distribution Center — Bulletin GEA-6619, 16 pp, contains complete data on company's dry-type integral distribution center for such applications as industrial plants and warehouses, office and commercial buildings, and others. Tells how one-piece construction saves space, simplifies specifying, ordering, and installation. Model numbers, dimensions, and choice of incoming line components are given. General Electric Co.

273 Battery Service Tips — Latest information on industrial batteries on cycle service is provided in the new edition, about 40 pp, of company's industrial battery service manual. Includes photos, charts, tables, repair methods, maintenance, and salient points on operation, instructions covering repairs with regular or special tools. Also covered are simplified testing methods (including safety prac-

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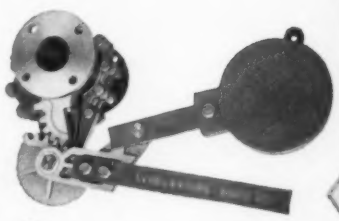

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to divert water to sprinkler deluge or water curtain systems, or to divert inflammable liquids to a point of safety.

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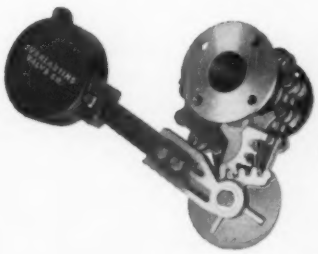

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tices and acid-handling precautions), and charging methods. C & D Batteries, Inc.

274 Cable Troughs — This 12-pp catalog offers a simple solution to any design problem of change of direction or elevation with a complete set of standard fittings, horizontal elbows, inside and outside vertical elbows, ties, crosses, covers and many special fastening devices to save time and labor. Contains full instructions for installations, load charts, accessory items. The Globe Co.

PACKINGS, SEALS

275 Mechanical Packings — Featured in 24-pp Catalog 56 are several recent packing developments including the multi-purpose Bel-Vee V-Ring packings, the long wearing criss-cross braid packing series, twisted foil packings for oil and distillate temperatures to 1000 F, and an Inconel-wire reinforced plastic packing for valves handling superheated steam at temperatures up to 800 C. Packings for every industrial application are covered. The Belmont Packing & Rubber Co.

276 Packing Catalog — Catalog 54 contains literature on company's line of packings and gaskets to serve a variety of industrial needs. Among the items featured are metallic packings, fibrous packings, plastic packings, gaskets and sheet packing, as well as high-temperature anti-seize compounds. Felt Products Mfg. Co.

FANS, VENTILATING

277 Air Engineering — Bulletin E-57 is a 24-pp air engineering data file covering engineering and test facilities for propeller fans, specifications, construction, maintenance, and installation. Tables for estimating air-handling requirements, entrance and elbow losses are provided. Aerovent Fan Co., Inc.

278 Ventilation Units — Bulletin FM-315, 25 pp, describes basic construction of company's package propeller fans for commercial and industrial applications. Illustrated case histories of typical installations are included, as well as performance data. Buffalo Forge Co.

OTHER EQUIPMENT

279 Centrifugal Dust Collector — Twelve-pp Bulletin 100 introduces the Cyclo-trell multiple tube dust collector which operates on centrifugal collection principles and incorporates new features to boost collection efficiency and gas handling capacity. An illustrated explanation of operation and construction of this collector is accompanied by collection efficiency and capacity nomographs. Research-Cottrell, Inc.

280 Preheating Combustion Air — This well-illustrated 36-pp booklet explains fuel savings and increased performance made possible by using waste heat in flue gases to preheat incoming combustion air. Also covers increased boiler output, ability to use lower grade fuels, other advantages afforded. Booklet contrasts regenerative with recuperative preheaters; explains operating principle and structural details of the Ljungstrom air preheater. Applications for other than power boilers are also covered. Air Preheater Corp.

281 Insulated Stack — This illustrated folder on company's pre-cast insu-

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lated stack contains complete product information, including advantages and description, specifications, suggested installation methods. Van-Packer Corp.

282 Low Pressure Heating Plant — Guide specifications for typical low-pressure commercial heating plants are presented in this 35-pp publication. Scope of guide specifications and basis of recommendations are detailed, and an index to specifications is given. Tabulated data are included along with drawings of typical boiler room, over fire air system, and stacks. Bituminous Coal Institute.

284 Equipment Selector Charts — Bulletin CE-50, 20 pp, contains selector charts on corrosion-resistant equipment for process industries. Tables cover general considerations in selection of material, physical properties, corrosion resistance, techniques and skill in manufacture of equipment. Describes rubber and plastic pipe, tubing and fittings; valves; pumps; lined tanks. American Hard Rubber Co.

285 Corrosion, Abrasion Control — Modern practices and products for the positive protection of metal equipment from the effects of corrosion and abrasion are described in this 16-pp bulletin. Covers factory and field application of rubber or synthetic linings to metal parts or products, and maintenance coatings available. Goodall Rubber Co.

287 Better Fuel Performance — This bulletin describes two of company's products designed for better fuel performance and economy. The first is a fuel oil sludge dispersant which prevents sludge and moisture separation in heavy fuel oil. The other is a soot remove Western Chemical Co.

288 Process Equipment - . letin G-3B describes equipment for process industries, including pneumatic conveying systems, compressors and vacuum pumps, coolers and preheaters, blowers, gas and vacuum pumps, fans and gas washers, accessories. In addition to describing features and advantages of the equipment, bulletin includes engineering data tables, photos and drawings. Fuller Co.

289 Belt Conveyor Equipment — Catalog 60-B, 150 pp, features specialized data regarding application of belt conveyors for handling of materials, along with a listing of belt conveyor equipment. Included are charts and tables to assist in the selection of proper conveyor units and equipment for any specific service and location requirements. This catalog is profusely illustrated with photos, drawings and diagrams. Webster Mfg., Inc.

290 Is Salt Just Salt? — This is the title of an 8-pp bulletin describing salt characteristics and properties as well as geographical distribution. Variations in salt from different areas in the United States are illustrated and company's refined salt products and applications are described. Morton Salt Co.

291 Steel Plate Construction — Pictured and described in this 20-pp bulletin are some of the steps in the fabrication of steel plate into boiler breechings, casings, duct work, stacks and special shapes, from initial design stage to final erection at plant site. The bulletin is generously illustrated with photos of typical plants utilizing these fabrications. They cover a wide range of industries, including paper, petroleum, steel, as well as utilities. Connery Construction Co.

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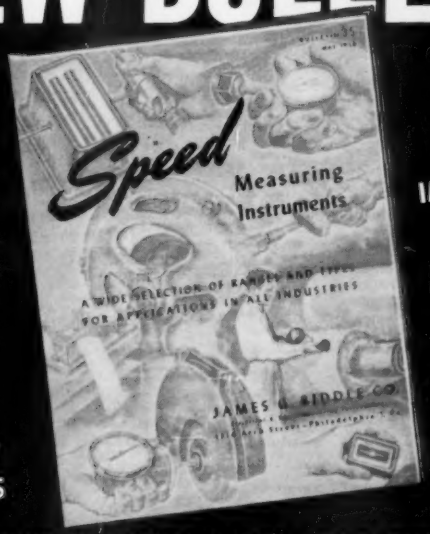

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JAGABI Tachoscope	Chronometric	up to 20,000 rpm	A stopwatch and revolution counter in one—Time and motion integrated mechanically
JAGABI Five-Range Hand Tachometer	Centrifugal	up to 48,000 rpm	5 individual ranges—Direct-indicating—Shows instantaneous speeds and speed variations
JAGABI Triple-Range Hand Tachometer	Centrifugal	up to 40,000 rpm	3 individual ranges—13-inch scale—Twice around dial—wide range in each range
JAGABI Single-Range Tachometer	Centrifugal	300 to 4,000 rpm	Exceptionally wide range—Double length 13-inch scale
JAGABI Single-Range Precision Hand Tachometer	Centrifugal	1,000 to 6,000 rpm	Dial diameter 120mm (4.7 in.) open, easy-to-read scale
JAGABI Tachograph	Centrifugal	up to 12,000 rpm	A recording tachometer—Provides permanent chart records
DR. HORN Hand Tachometer	Centrifugal	up to 30,000 rpm	6 ranges—Simple, sturdy construction—Overspeed protection
JONES Single-Range Hand Tachometer	Centrifugal	up to 10,000 rpm	Open equi-spaced scale—with stop button
JONES Double-Range Hand Tachometer	Centrifugal	up to 5,000 rpm	Open equi-spaced scale—with stop button
JONES Triple-Range Hand Tachometer	Centrifugal	up to 50,000 rpm	Open equi-spaced scale—with stop button
JONES Stationary Tachometers	Continuous indicating fixed type	up to 10,000 rpm	3", 4" and 6" diameter-dials—Uniform scale divisions—Heavy duty
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FRAHM Hand Tachometers	Resonant Reed	900 to 100,000 rpm	Easy to use—Safe—No contact with moving parts—No wearing parts—No oiling—No maintenance—Not injured by overspeeding—Imposes no load on small motors or machines under test
SWEENEY Tachometer Tester	Built on the synchronous motor principle		Tests all but the resonant reed type tachometers—Accurate as an electric clock

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NEW ENGINEERING BOOKS

Proceedings of the Second RETMA Conference on Reliable Electrical Connections. 103 pages, 53 illustrations, paper bound. Published by Engineering Publishers, GPO Box 1151, New York 1, N. Y. $5.00.

The modern world depends on reliable electrical connections. In our homes and factories, in transportation and communications, and in national defense our welfare, our comforts and pleasures, even our lives have become dependent on the reliability of electrical connections.

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The subject matter includes soldered connections, solderless connections, brazed connections, ultrasonic joining, equipment and tools, fluxes, surface qualities, soldering to printed wiring boards, contamination, solderable wire coatings, operator influence, reliability evaluation and other material.

The book is the proceedings of the Second RETMA Conference on Reliable Electrical Connections, sponsored by the Radio-Electronics-Television Manufacturers Association and the Department of Defense Advisory Group on Electronic Parts.

★ ★ ★

Advanced Dynamics, by John E. Younger. Size 6 by 9 in., 258 pages. Published by The Ronald Press Co, 15 E 26 St, New York 10, N. Y. Price $8.50.

Aimed at the needs both of advanced students and practicing engineers, this book presents many carefully selected examples which illustrate the application of fundamental principles and methods. These examples have been worked out in detail, sometimes using more than one method of approach, and the physical significance of the mathematical steps is explained.

This text is based on the author's quarter century of teaching dynamics. Mr. Younger is professor and chairman of the Department of Mechanical Engineering at the University of Maryland.

★ ★ ★

Standard Handbook for Electrical Engineers. Ninth Edition. Prepared by a Staff of Specialists under the Editorship of Archer E. Knowlton, Consulting Editor, *Electrical World.* 2311 pages, illustrated. McGraw-Hill, 330 W 42nd St, New York 36, N. Y. Price, $19.50.

This widely-known handbook has now been published in a considerably revised and modernized Ninth Edition. The revision has been planned to incorporate important facts and data from all the vast changes and developments in materials, methods, and applications that have taken place during the eight years since the last edition.

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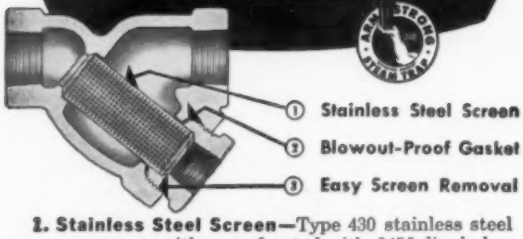

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The Chemical Industry Facts Book. Third Edition, 1957. 160 pages, 6 by 9 in., paper. Published by the Manufacturing Chemists' Association, Inc, 1625 Eye St, N.W., Washington 6, D. C. Price $1.25.

First published in 1953, this handy reference work has been up-dated to give detailed accurate information about the chemical industry as it is today. There are 15 chapters ranging from the industry's role in the economy to such specifics as chemicals and nuclear energy. Profusely illustrated with charts, graphs and tables.

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Pump Operation and Maintenance, by Tyler G. Hicks. 275 pages, 6 by 9 in., cloth. Published by McGraw-Hill Book Co, 330 W 42nd St, New York 36, N. Y. Price $9.00.

Written in practical, non-technical language, this book covers practically all phases of pump installation, starting, operation and maintenance.

In addition to the more common varieties of pumps, the book covers such specialties as steam, power, metering and proportioning, oil-hydraulic, food and chemical handling, and other types.

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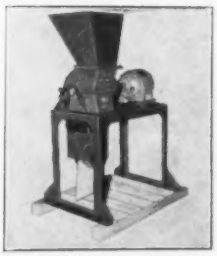

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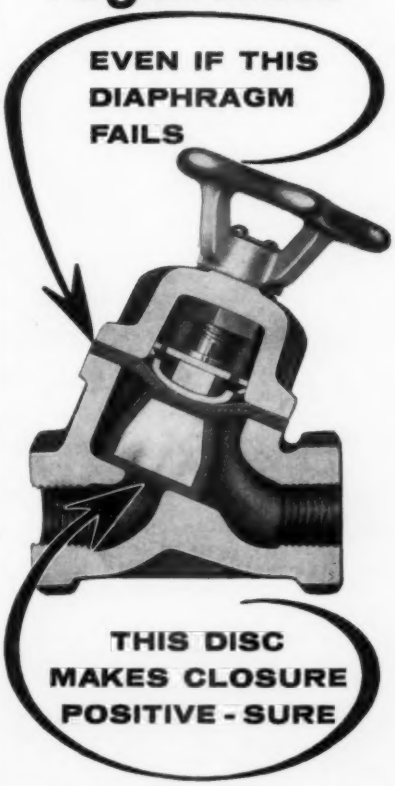

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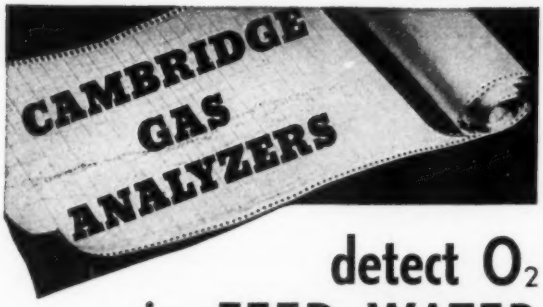

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3552 Grand Central Terminal, N. Y. 17, N. Y.
Pioneer Manufacturers of Precision Instruments

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The easiest—and quickest—way to order bulletins and catalogs described in this magazine is to use the postage-free Reader Service Cards on pages 127–128.

All you need to do is circle the item numbers of those you want. Then fill in your name, job title, company name and address—and mail the card.

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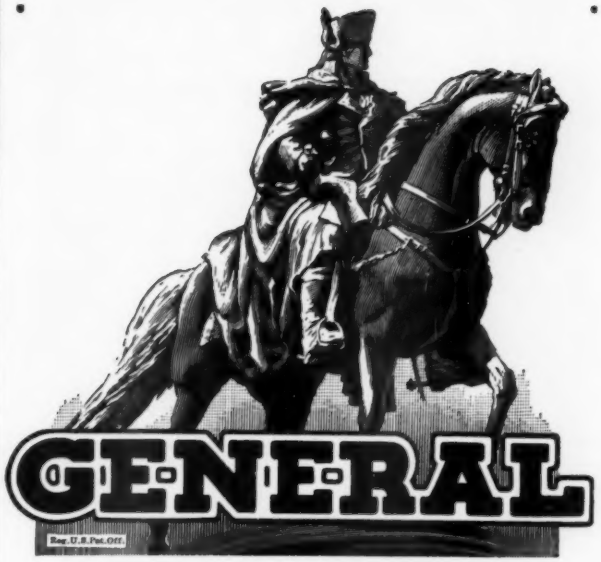

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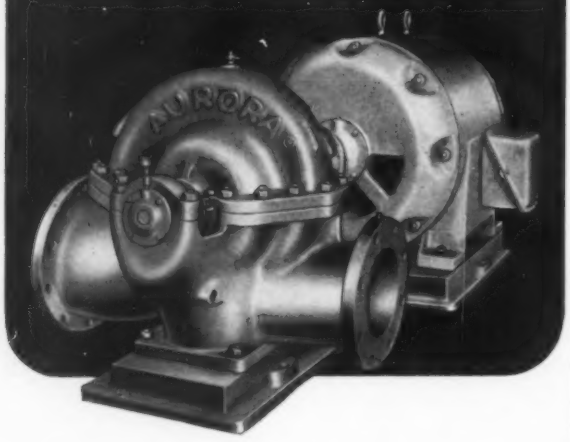
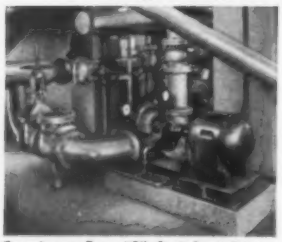


Just one more important reason these AURORA® HORIZONTAL SPLIT CASE, DOUBLE SUCTION CENTRIFUGAL PUMPS give greater servive



Two Aurora Type "O" Centrifugal Pumps, driven by 15HP, 1150 RPM motors are serving as cooling tower pumps in the plant of C. Schmidt & Sons, Inc., Brewers, Philadelphia, Pennsylvania.

Two Aurora Type "O" Condensation Water Pumps are installed in the Hillsborough County Courthouse, Tampa, Florida. Duty, 1400 GPM against 50' TDH at 1750 RPM.

Whether municipality or industry, you want a pump built for long, maintenance-free life. Equally important, when maintenance *is* needed, you want lines back in service fast!

These Aurora Type OJ centrifugal pumps are built for rugged service, and can be quickly maintained without disturbing suction or discharge piping or pump-motor-base alignment.

They are ideal for municipal or industrial water service for line pressure build-up, boosting to pressure tanks or elevated tanks, cooling tower service, fuel transfer, fire pumps, marine service, circulating, boiler feed service and many other general applications.

For complete range and engineering information, write for Bulletin 105-B

AURORA Always PUMPS

AURORA PUMP DIVISION
THE NEW YORK AIR BRAKE COMPANY
49 DEARBORN ST. AURORA • ILLINOIS

For more data circle 577 on Post Card

two holes in the sky...

cool water for air conditioning

Two 16' 4-blade "AL-Metal" Propellers, ***efficiency-engineered*** to this application, keep working temperatures uniform in a large midwestern office building. By the people who designed and developed the famous "Macheta" Airfoil Propeller — acclaimed as ***industry's most efficient air-moving surface!***

Photo courtesy Watercooling Equipment Co., St. Louis

Write for free Bulletin 510.

Aerovent
FAN COMPANY, INC.
ASH and BRUSH STS. • PIQUA, OHIO
304 Wright Bldg. • Tulsa 3, Oklahoma

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POWELL

world's largest family of valves

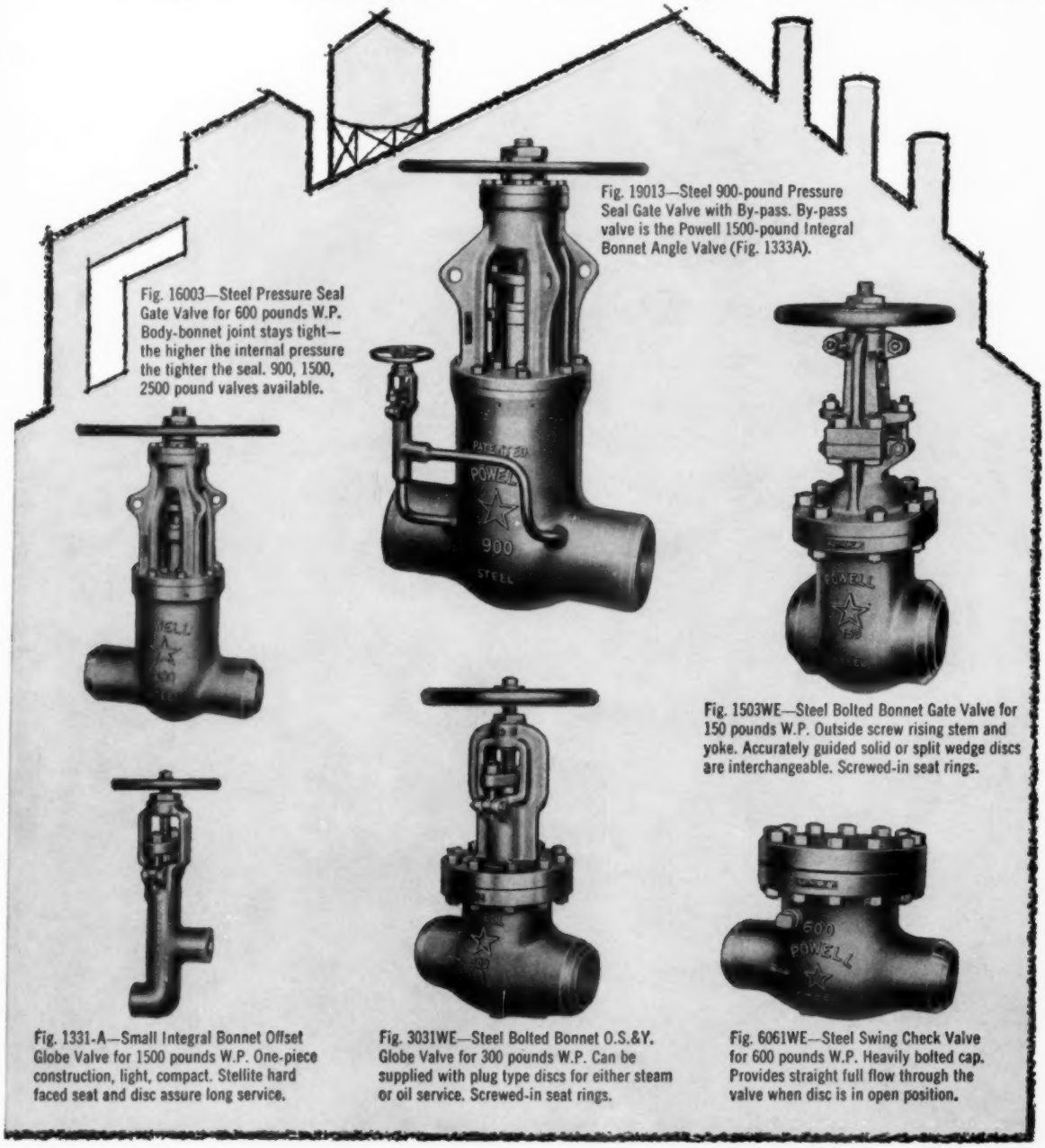

Fig. 19013—Steel 900-pound Pressure Seal Gate Valve with By-pass. By-pass valve is the Powell 1500-pound Integral Bonnet Angle Valve (Fig. 1333A).

Fig. 16003—Steel Pressure Seal Gate Valve for 600 pounds W.P. Body-bonnet joint stays tight—the higher the internal pressure the tighter the seal. 900, 1500, 2500 pound valves available.

Fig. 1503WE—Steel Bolted Bonnet Gate Valve for 150 pounds W.P. Outside screw rising stem and yoke. Accurately guided solid or split wedge discs are interchangeable. Screwed-in seat rings.

Fig. 1331-A—Small Integral Bonnet Offset Globe Valve for 1500 pounds W.P. One-piece construction, light, compact. Stellite hard faced seat and disc assure long service.

Fig. 3031WE—Steel Bolted Bonnet O.S.&Y. Globe Valve for 300 pounds W.P. Can be supplied with plug type discs for either steam or oil service. Screwed-in seat rings.

Fig. 6061WE—Steel Swing Check Valve for 600 pounds W.P. Heavily bolted cap. Provides straight full flow through the valve when disc is in open position.

For every flow control problem Powell offers more kinds or types, available in the largest variety of metals and alloys to handle every flow control requirement. Powell distributors are located in all principal cities and maintain inventories to fill almost any need. For special engineering problems, write direct to:

THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**

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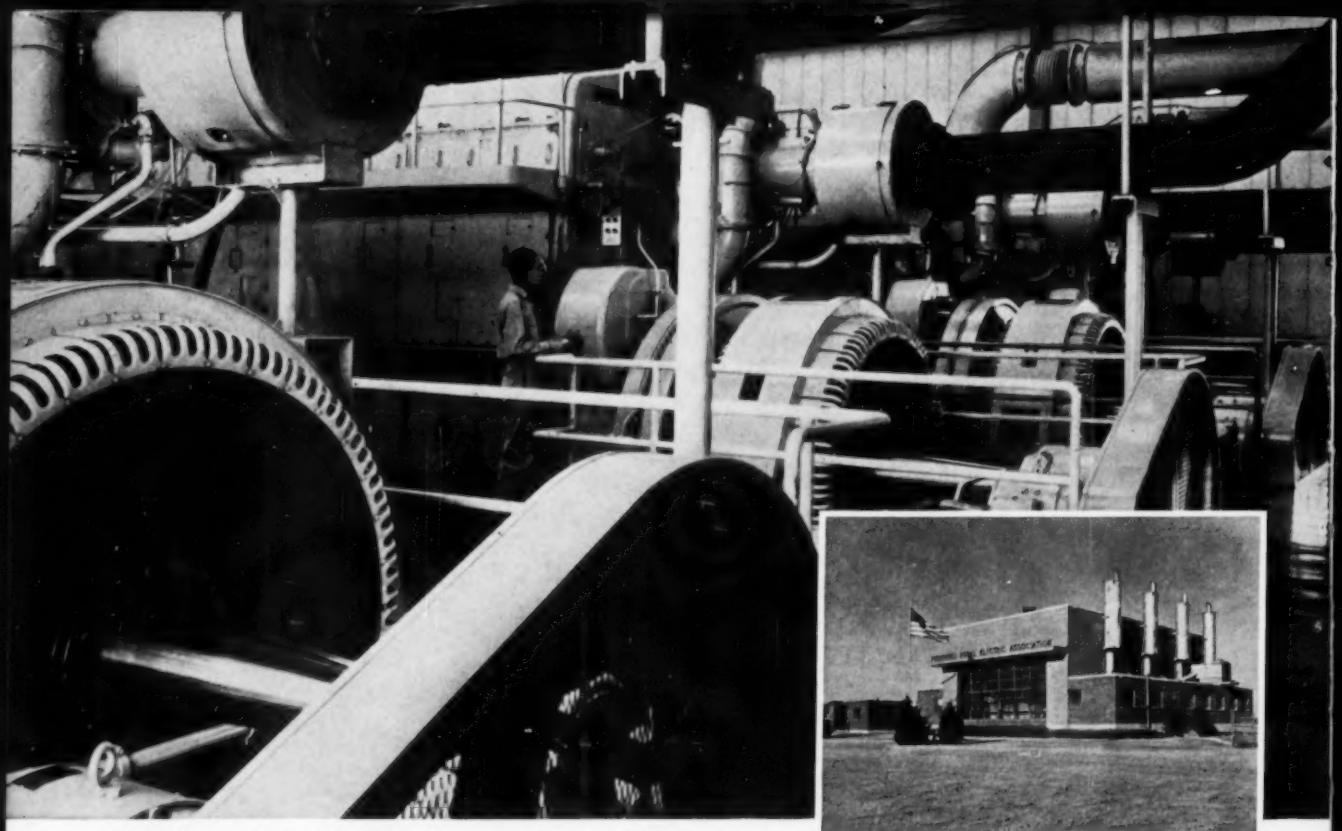


EFFICIENCY AWARD for 1957 (Division A) goes to Federated Rural Electric Assn. for producing power at the low cost of only 6.54 mills per kwh. Manager Paul L. Ferguson reports that "Lubrication with Texaco Ursa Oil Heavy Duty, and frequent thorough engine checks, have kept average liner wear (all engines, all cylinders) down to 0.005" after 33,000 hours' operation."

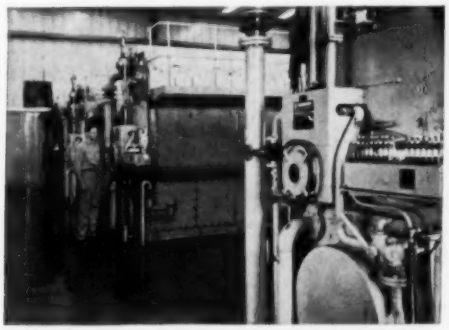
A GOOD NEIGHBOR as well as an efficient one, Federated's modern plant is handsomely landscaped, and the engines exhaust into Maxim silencers.

"MOST EFFICIENT" REA PLANT WINS TITLE WITH TEXACO

A combination of rigid maintenance standards and the use of Texaco Ursa Oil Heavy Duty has won two *Diesel Progress* awards for efficiency for Federated Rural Electric Association, Jackson, Minn. In 1954, and again in 1957, Federated was named "the most efficiently operated of all REA internal combustion plants." This is how Texaco has helped Federated stay on top:

Texaco Ursa Oil Heavy Duty keeps engines clean, for maximum efficiency. It prevents formation of sludge, keeps the rings free and compression high, so the engine uses less fuel, and runs longer between scheduled overhauls.

Minimizes wear, too. Texaco Ursa Oil Heavy Duty is a premium quality lubricant—one of a complete line of Texaco Ursa Oils especially refined and processed to lubricate diesel, gas and dual-fuel engines. For details on what Texaco Ursa Oils can do in your plant, call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.



POWERFUL PERFORMERS stay powerful with Texaco Lubrication. Each 8-cylinder 4-cycle Nordberg Dua-fuel engine is rated at 1750 hp at 327 rpm.

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